United States
Department of
Agriculture

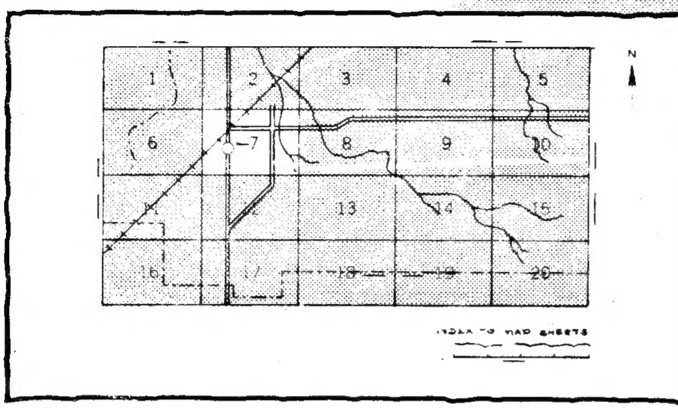
Soil
Conservation
Service

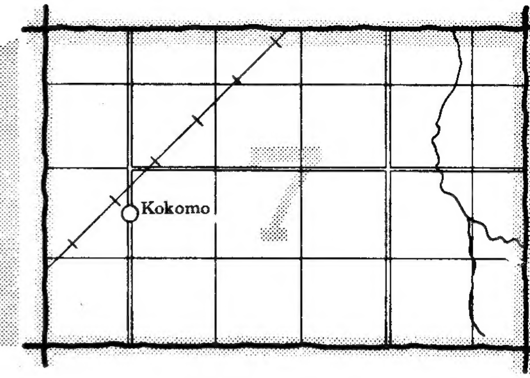
In cooperation with
Missouri Agricultural
Experiment Station

Soil survey of Clinton County Missouri

HOW TO USE

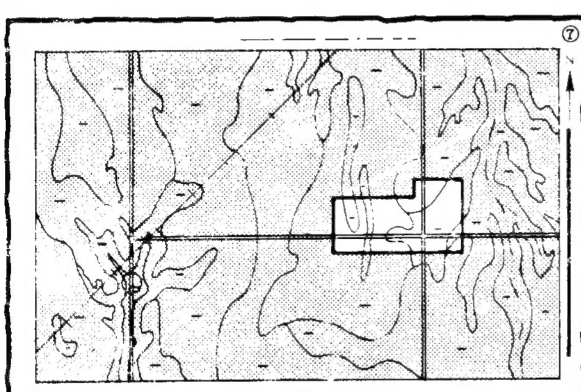
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

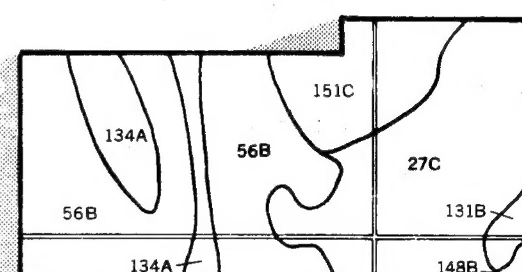




2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





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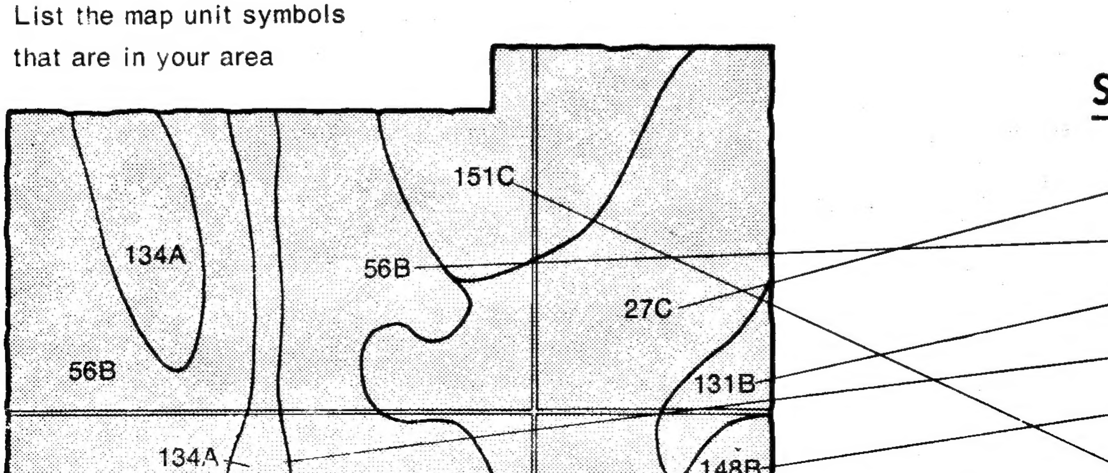

Symbols

27C
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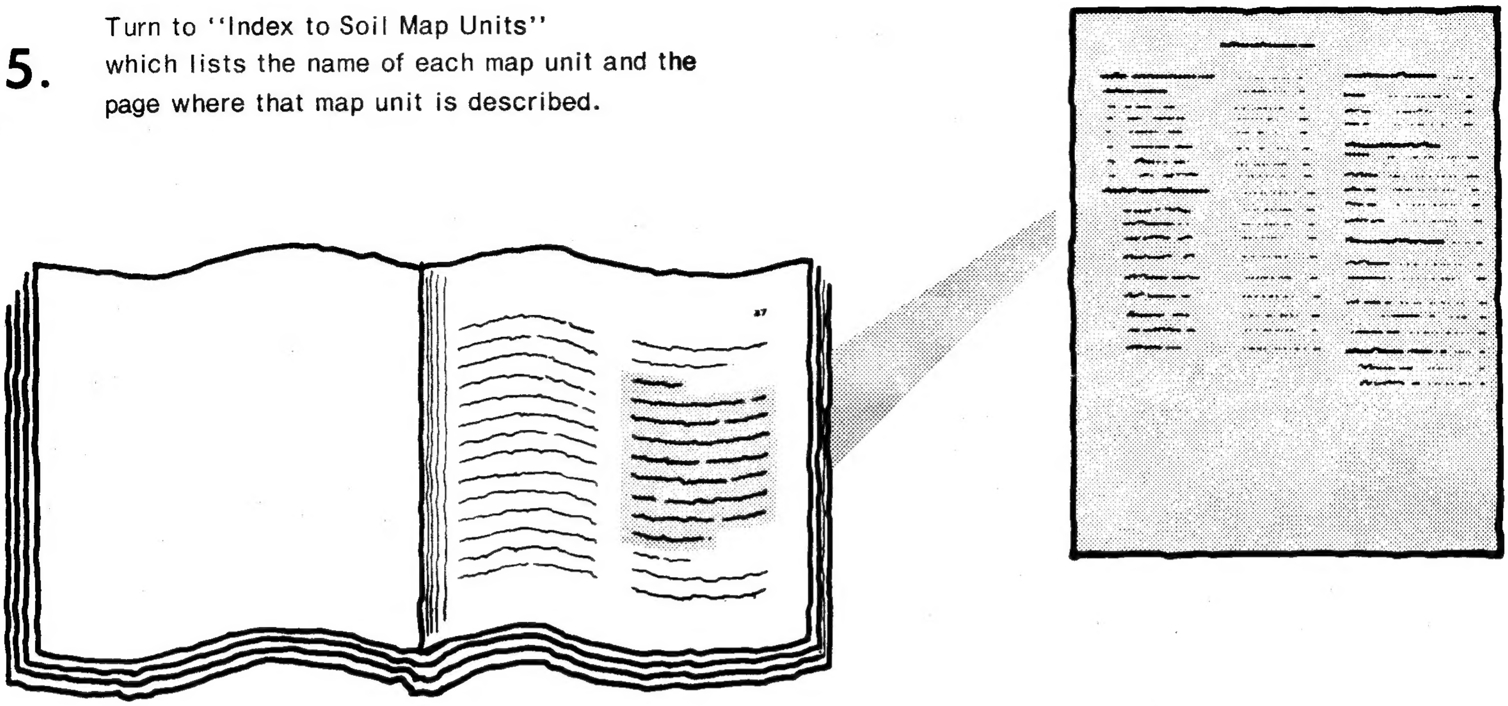
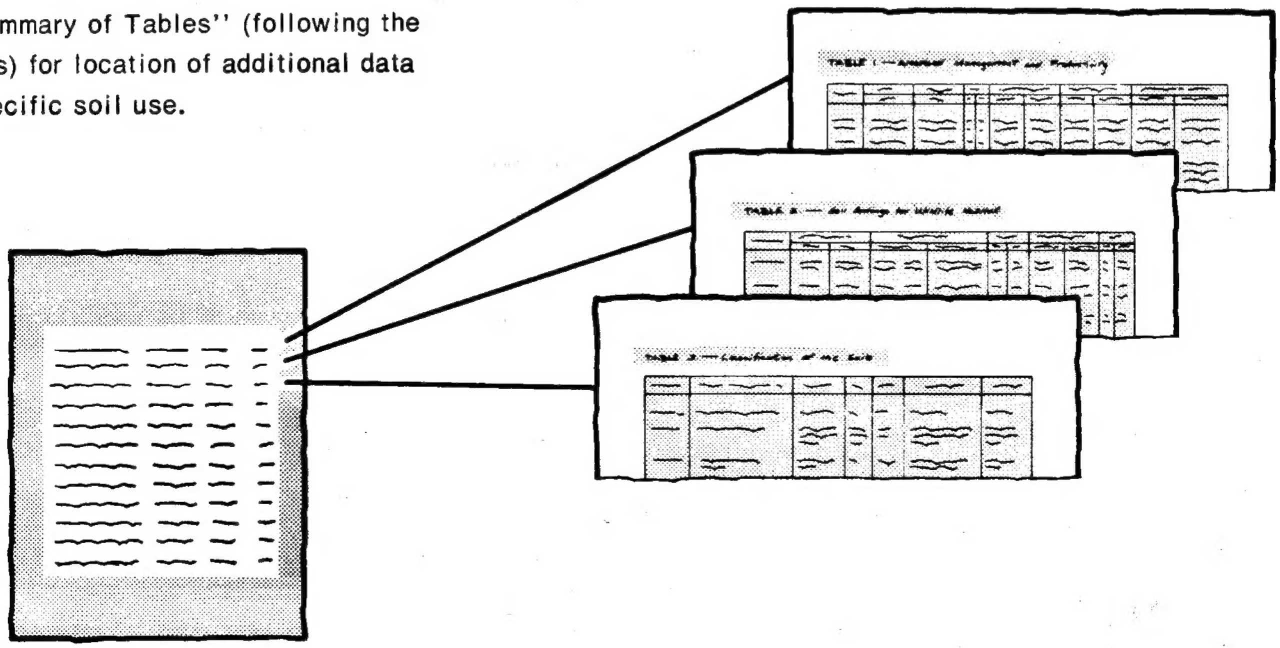
THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Missouri Agricultural Experiment Station, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. The Clinton County Court provided funds for maps and supplies to assist in the survey. The Missouri Department of Natural Resources contributed funds to assist in map finishing. This soil survey is part of the technical assistance furnished to the Clinton County Soil and Water Conservation District.

Major fieldwork for this survey was performed in the period 1977-1980. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Grasses and legumes grown for pasture and hay effectively control erosion on Grundy silt loam, 2 to 5 percent slopes.

contents

soil series

Issued April 1983

index to map units

summary of tables

foreword

This soil survey contains information that can be used in land-planning programs in Clinton County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

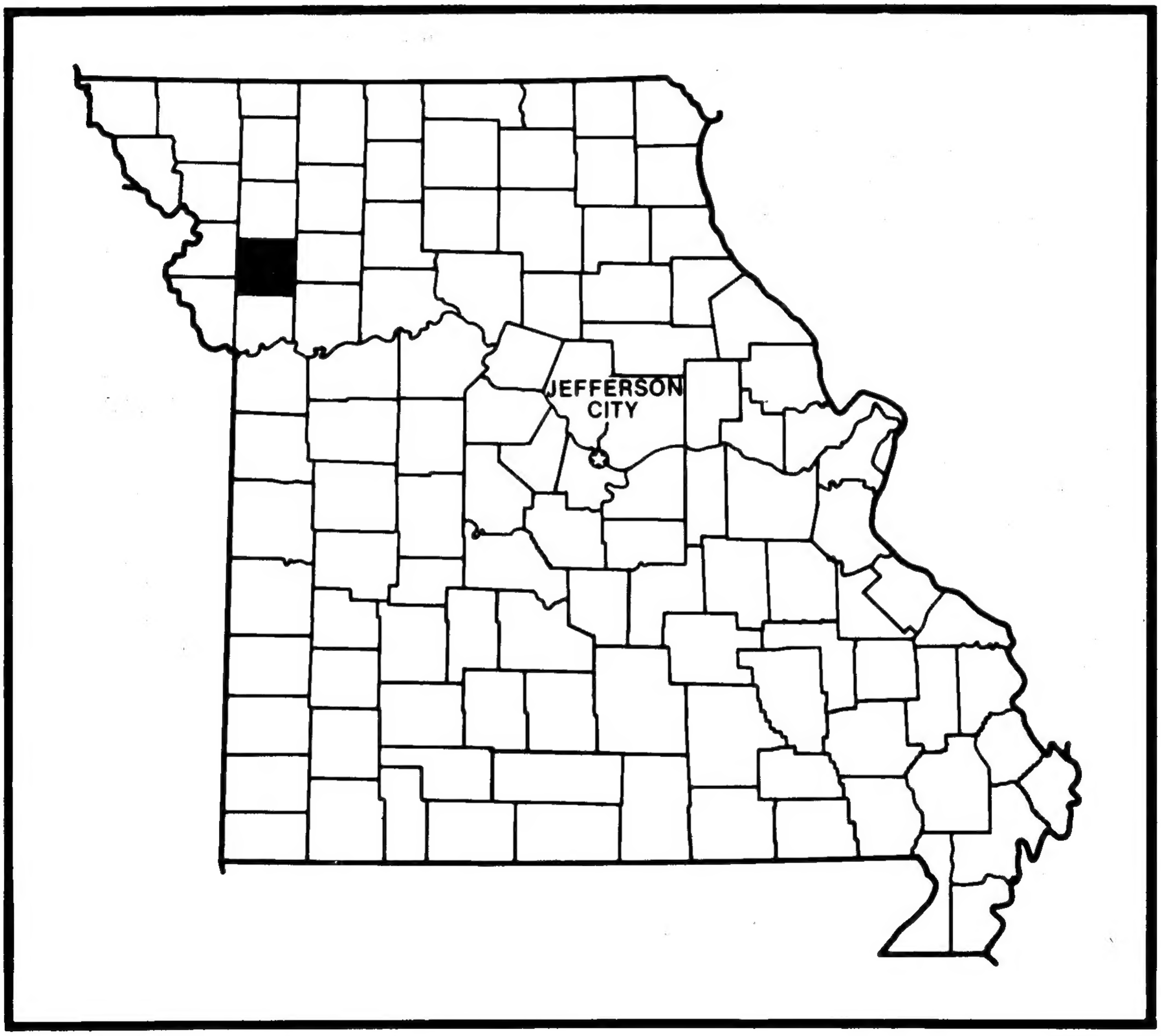
This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Paul F. Larson

Paul F. Larson
State Conservationist
Soil Conservation Service



Location of Clinton County in Missouri.

soil survey of
Clinton County, Missouri

By Paul E. Minor and Keith O. Davis, Soil Conservation Service

Fieldwork by Paul E. Minor and Keith O. Davis, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
in cooperation with the Missouri Agricultural Experiment Station

CLINTON COUNTY is in the northwestern part of Missouri. Plattsburg, the county seat, is 25 miles southeast of St. Joseph and 30 miles north of Kansas City. In 1970, the population of the county was 12,462. The population of Plattsburg was 1,832. The county takes in an area of 268,800 acres, or 420 square miles.

Farming is the main enterprise in Clinton County. The main crops are corn, soybeans, sorghum, legumes, and grasses. Raising beef cattle is the largest livestock enterprise. Hogs, dairy cattle, and sheep are also raised.

general nature of the county

In this section, climate; physiography, relief, and drainage; history and development; and farming are discussed.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Clinton County consistently has cold winters and long, hot summers. Heavy rains occur mainly in spring and early in summer, when moist air from the Gulf of Mexico interacts with drier continental air. The annual rainfall normally is adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at St. Joseph, Missouri, in the period 1952 to 1979. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 29 degrees F, and the average daily minimum temperature is 19 degrees. The lowest temperature on record, which occurred at St. Joseph on January 12, 1974, is -25 degrees. In summer the average temperature is 76 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred on July 13, 1954, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 34 inches. Of this, 24 inches, or 70 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 19 inches. The heaviest 1-day rainfall during the period of record was 5.88 inches at St. Joseph on May 19, 1962. Thunderstorms occur on about 55 days each year, and most occur in summer.

The average seasonal snowfall is 21 inches. The greatest snow depth at any one time during the period of record was 18 inches. On the average, 10 days have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter.

The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

Tornadoes and severe thunderstorms occur occasionally. They are local and of short duration. Damage varies and is spotty. Hailstorms occur occasionally, during the warmer part of the year, in an irregular pattern and in small areas.

physiography, relief, and drainage

The landscape in Clinton County is mainly gently sloping to strongly sloping upland. A system of wide, gently sloping ridges extends southward through the county, beginning in the north-central part. The county drains generally to the south. The northeastern part, however, drains to the north and east.

All of the streams are small. The bottom lands are narrow and make up less than 10 percent of the total acreage. Rock outcrops and shallow soils are common in the areas adjacent to the main streams.

history and development

Settlers came to the area that is now Clinton County around 1825 and settled first in the southwestern part (*9*). Most of the early settlers lived near the larger streams in predominantly wooded areas. Wildlife, wood, and water were plentiful.

In 1833 the county was organized and named in honor of DeWitt Clinton, a prominent New York statesman.

The county seat was originally called Concord. In 1834 the name was changed to Springfield. A later change to Plattsburg was permanent. The most famous resident of the town was Senator David R. Atchison. In 1849, as president pro tempore of the Senate, he was President of the United States for one day in the interim between Presidents Polk and Taylor (*9*).

The Hannibal and St. Joseph Railroad was completed through the county in 1857. By the early 1870's, three other railroads crossed Clinton County (*9*). The Chicago, Burlington and Quincy line is still active.

In the late 1850's, a settlement began to develop in the northeastern part of Clinton County. In 1867 it was officially named Cameron (*11*). Cameron is located at the junction of U.S. 36 and Interstate 35 and is the largest town in the county. Important smaller communities are Turney and Lathrop in the central part of the county and Grayson and Trimble in the southwestern part. The eastern half of Gower is in Clinton County, where U.S. 169 enters from Buchanan County on the west.

In 1978 construction was completed on the Smithville Dam. The permanent pool of the Smithville reservoir covers approximately 3,400 acres in the southwestern part of the county.

The main east-west highway through Clinton County is Missouri 116. Most north-south travel is on Interstate 35, in the eastern part of the county. Other north-south highways are U.S. 169 and 69 and Missouri 33.

farming

Early settlers in Clinton County located along the major streams. The areas were mostly woodland, and game animals were abundant. The settlers raised a few cows, hogs, and chickens and planted corn, wheat, and hemp.

In 1900 there were 2,024 farms in Clinton County. That number declined steadily; in 1964 there were 972 farms in the county. In 1978 there were 845 farms. In that year the average farm size was 261 acres (*16*).

Livestock made up about 72 percent of all farm products sold in 1974. By 1975, the number of cattle had increased to 69,700, and the number of hogs increased to 43,800. Since 1975, the number of cattle has declined sharply, and the hog population has increased. In 1978 there were approximately 54,800 cattle and 56,400 hogs and pigs in Clinton County (*6*).

In 1978 about 60 percent of the farm operators worked off the farm part of the time. About 49 percent worked off the farm 100 days or more out of the year (*16*).

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists.

For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit, or soil association, on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some of the boundaries on the soil maps of Clinton County do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. The differences are a result of additional soil data or of correlation decisions that reflect local variations. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area. In some places it is more feasible to combine small acreages of similar soils that respond to use and management in much the same way than it is to separate the soils and give them different names.

soil descriptions

1. Grundy association

Somewhat poorly drained soils that formed in loess

This association consists of gently sloping soils on wide ridgetops and moderately sloping soils on concave side slopes that are dissected by narrow, branching drainageways (fig. 1).

This association makes up about 34 percent of the county. It is about 88 percent Grundy and similar soils. The remaining 12 percent is minor soils.

Grundy soils have a surface layer of black silt loam and a subsurface layer of black, friable silty clay loam. The subsoil is very dark gray, dark grayish brown, and grayish brown, mottled, firm silty clay loam and silty clay. The substratum is mottled, grayish brown and light brownish gray silty clay loam.

The minor soils are poorly drained Haig soils on wide ridgetops; moderately well drained Sharpsburg soils on narrow ridgetops; Lamoni soils, which are similar to Grundy soils; and poorly drained Colo soils on narrow drainageways.

In most areas the soils in this association are used for cultivated crops, hay, and pasture (fig. 2). The soils are suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes for hay and pasture. Slope and the hazard of erosion are the main management concerns. Surface wetness is a problem in spring and fall when tillage and harvesting are done. Overgrazing and grazing when the soils are wet are the major concerns in pasture management.

The soils are suitable for sanitary facilities and building site development if proper design and installation procedures are used. Wetness, slow permeability, and the high shrink-swell potential are the main limitations.

2. Sharpsburg-Higginsville-Lamoni association

Somewhat poorly drained and moderately well drained soils that formed in loess and glacial till

This association consists of gently sloping soils on narrow convex ridgetops and moderately sloping soils on concave side slopes that are dissected by narrow, branching drainageways (fig. 3).

This association makes up about 19 percent of the county. It is about 38 percent Sharpsburg and similar soils, 30 percent Higginsville soils, and 19 percent Lamoni and similar soils. The rest is minor soils.

Sharpsburg soils are moderately well drained and are on narrow convex ridgetops and on convex side slopes. Their surface layer is black silty clay loam, and the subsurface layer is very dark brown silty clay loam. The subsoil is dark brown, dark yellowish brown, and yellowish brown silty clay loam. The substratum is mottled, grayish brown and yellowish brown silty clay loam.

Higginsville soils are somewhat poorly drained and are on concave side slopes near the head of drainageways at lower elevations than Sharpsburg soils. Their surface layer is black silt loam, and the subsurface layer is very dark gray silty clay loam. The subsoil is dark grayish brown and grayish brown, mottled silty clay loam. The substratum is grayish brown, mottled silty clay loam.

Lamoni soils are somewhat poorly drained and are on the lower part of concave side slopes farther from the

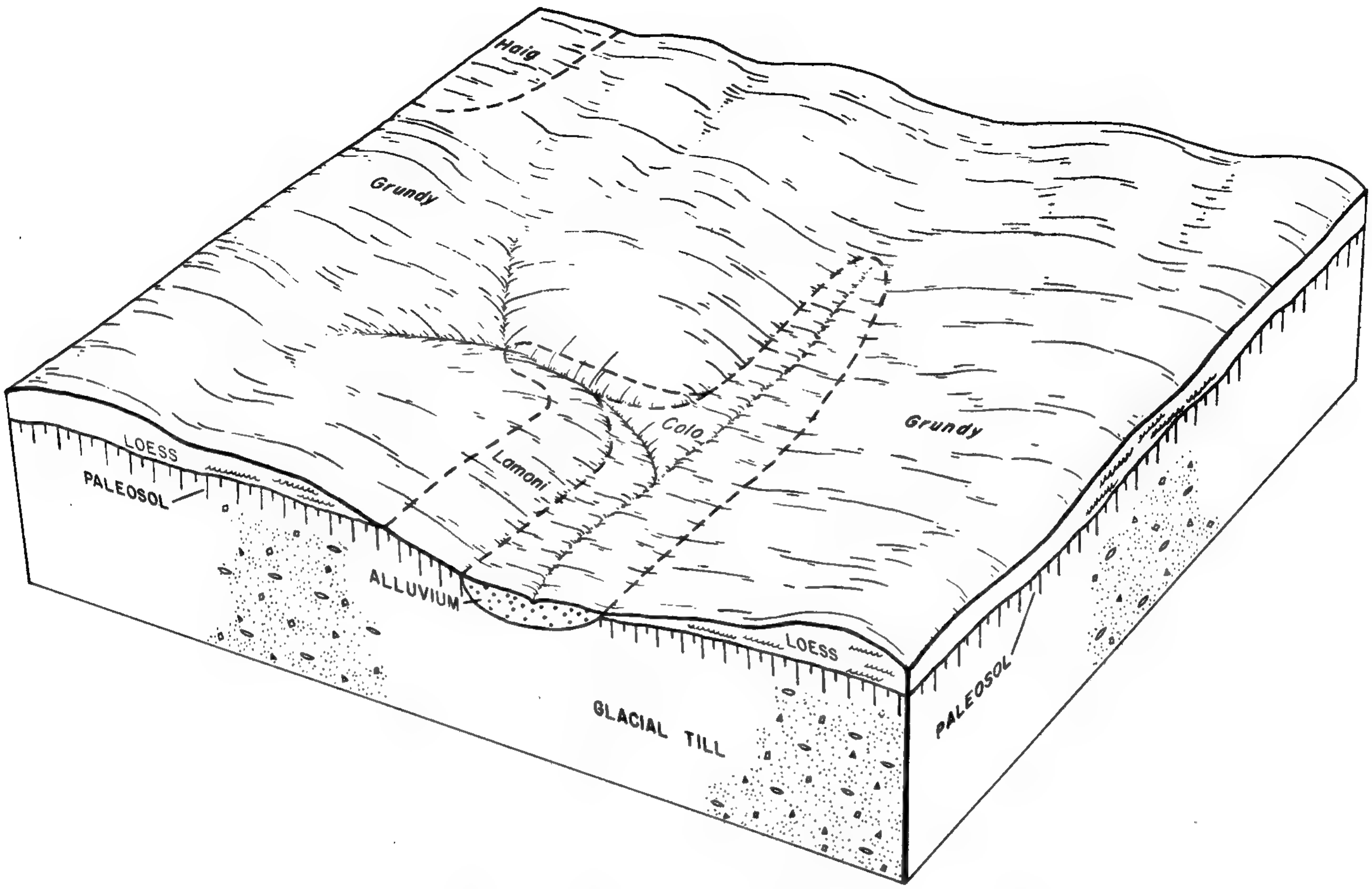


Figure 1.—Typical pattern of soils and parent material in the Grundy association.

head of drainageways than Higginsville soils. Their surface layer is black silty clay loam, and the subsurface layer is very dark gray clay loam. The subsoil is dark grayish brown and grayish brown, mottled clay loam and clay.

The minor soils are the poorly drained Colo soils on narrow drainageways, the more silty Kennebec soils on wider drainageways, and Grundy soils, which are similar to Lamoni soils.

The soils in this association are used mainly for cultivated crops, hay, and pasture. The soils are suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes for hay and pasture. Slope and the hazard of erosion are the main management concerns. Surface wetness is a problem on Higginsville and Lamoni soils in spring and fall when tillage and harvesting are done. Overgrazing and grazing when the soils are wet are the major concerns in pasture management.

The soils in this association are suitable for sanitary facilities and building site development if proper design and installation procedures are used. Wetness, slow permeability, and the high shrink-swell potential are limitations on Higginsville and Lamoni soils. The moderate shrink-swell potential and moderately slow permeability are the main limitations on Sharpsburg soils.

3. Lamoni association

Somewhat poorly drained soils that formed in glacial till

This association consists of moderately sloping soils on narrow ridges and strongly sloping soils on concave side slopes that are dissected by narrow, branching drainageways (fig. 4).

This association makes up about 11 percent of the county. It is about 60 percent Lamoni and similar soils and 40 percent minor soils.

Lamoni soils are on concave side slopes. Their surface layer is black silty clay loam, and the subsurface layer is very dark gray clay loam. The subsoil is dark grayish brown and grayish brown, mottled clay loam and clay.

The minor soils are the moderately well drained Sharpsburg soils on narrow ridgetops, the poorly drained Clarinda soils in slightly higher positions than those of

Figure 2.—The soils in the Grundy association are used mainly for cultivated crops, hay, and pasture.

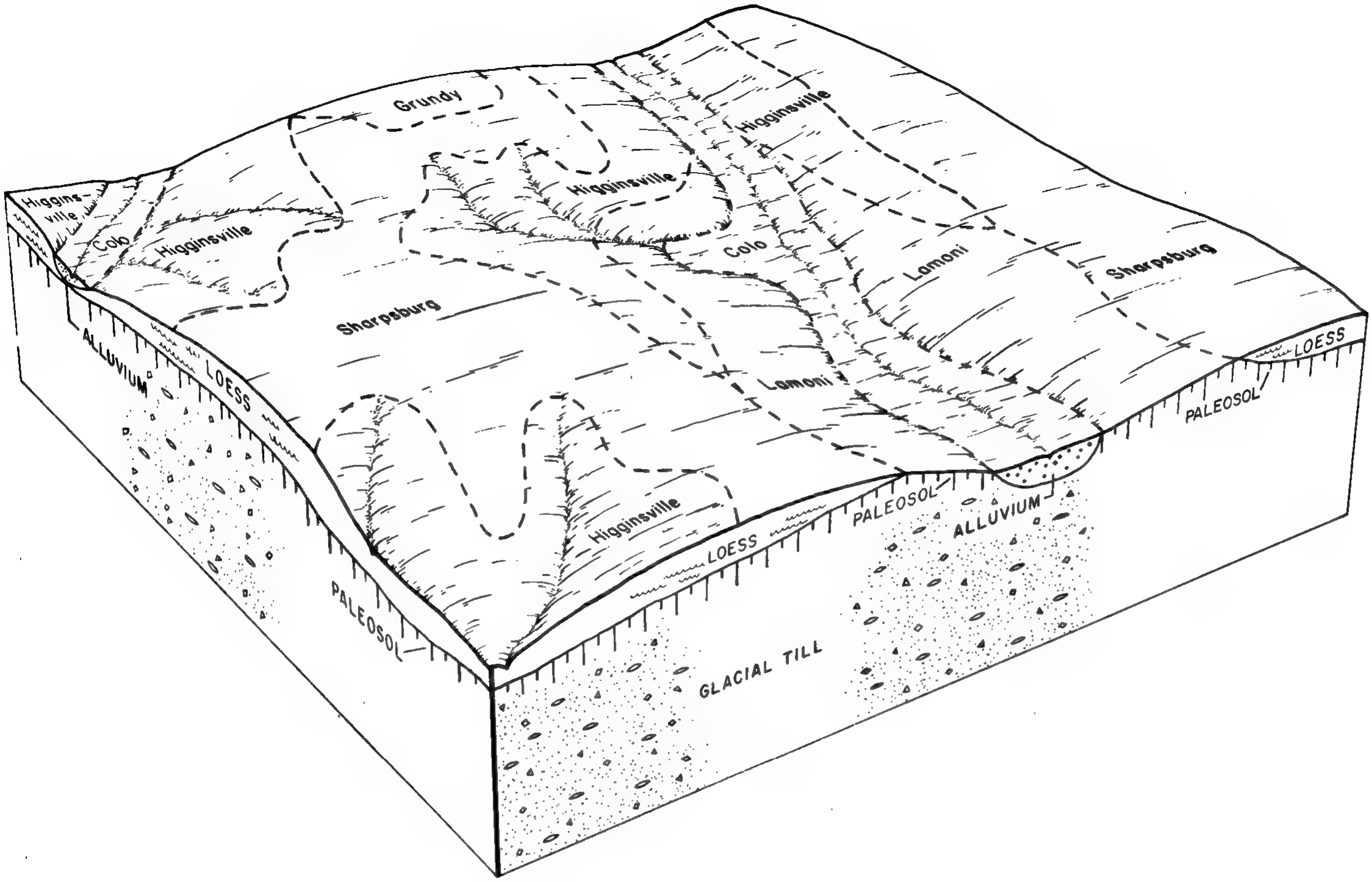


Figure 3.—Typical pattern of soils and parent material in the Sharpsburg-Higginsville-Lamoni association.

Lamoni soils, the moderately well drained Shelby soils on side slopes adjacent to narrow drainageways, the poorly drained Colo soils on narrow drainageways, and Grundy soils, which are similar to Lamoni soils.

In most areas the soils in this association are used for cultivated crops, hay, and pasture. Slope and the hazard of erosion are the main management concerns. Surface wetness is a problem in spring and fall when tillage and harvesting are done. The moderately sloping soils are suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes for hay and pasture. The strongly sloping soils are best suited to grasses and legumes for hay and pasture. Overgrazing and grazing when the soils are wet are the major concerns in pasture management.

The soils are suitable for sanitary facilities and building site development if proper design and installation procedures are used. Wetness, slow permeability, and the high shrink-swell potential are the main limitations.

4. Armstrong-Gara-Ladoga association

Moderately well drained and somewhat poorly drained soils that formed in loess and glacial till

This association consists of gently sloping and moderately sloping soils on narrow ridges and strongly sloping to moderately steep soils on deeply dissected hillsides adjacent to large drainageways (fig. 5).

This association makes up about 32 percent of the county. It is about 35 percent Armstrong soils, 22 percent Gara soils, and 11 percent Ladoga soils. The remaining 32 percent is minor soils.

Armstrong soils are somewhat poorly drained and are on narrow ridgetops and side slopes. Their surface layer is very dark grayish brown loam. The subsoil is brown, mottled, firm clay loam and clay in the upper part and mottled, strong brown and gray, firm clay loam in the lower part.

Gara soils are moderately well drained and are on convex side slopes. Their surface layer is very dark

grayish brown loam, and the subsurface layer is grayish brown loam. The subsoil is yellowish brown, firm clay loam. The substratum is yellowish brown, mottled, calcareous, firm clay loam.

Ladoga soils are moderately well drained and are on ridgetops and side slopes. Their surface layer is very dark grayish brown silt loam. The subsoil is dark yellowish brown silty clay loam in the upper part and dark yellowish brown, mottled silty clay in the lower part. The substratum is yellowish brown, mottled silty clay loam.

The minor soils are the somewhat excessively drained Gasconade soils and moderately deep Vanmeter soils on side slopes adjacent to large drainageways; the Clinton soils, which have a light colored surface layer and are on narrow ridgetops; the more silty Nevin and Wiota soils and the poorly drained Bremer soils on stream terraces; and the more silty Kennebec and Nodaway soils and the poorly drained Colo soils on narrow flood plains.

In some areas the soils in this association are used for cultivated crops and hay. In most areas they are used for grass pasture, woodland pasture, small housing developments, and as recreation areas. This association includes Smithville Lake.

These soils are suitable for pasture and hay. The gently sloping and moderately sloping soils are suitable for corn, soybeans, grain sorghum, small grains, and grasses and legumes. Slope and the hazard of erosion are the main management concerns. Overgrazing and grazing when the soils are wet are major concerns in pasture management.

The soils in this association are suitable for trees. The native vegetation was mixed hardwoods, and in some areas the soils remain in timber. Hazards and limitations are few to moderate and are easily overcome.

These soils are suitable for sanitary facilities and building site development if proper design and installation procedures are used. Wetness, slow permeability, and the high shrink-swell potential are limitations on the Armstrong soils. Moderately slow permeability and the moderate shrink-swell potential are limitations on the Gara, Clinton, and Ladoga soils. Slope is a major limitation where the Armstrong and Gara soils are strongly sloping and moderately steep.

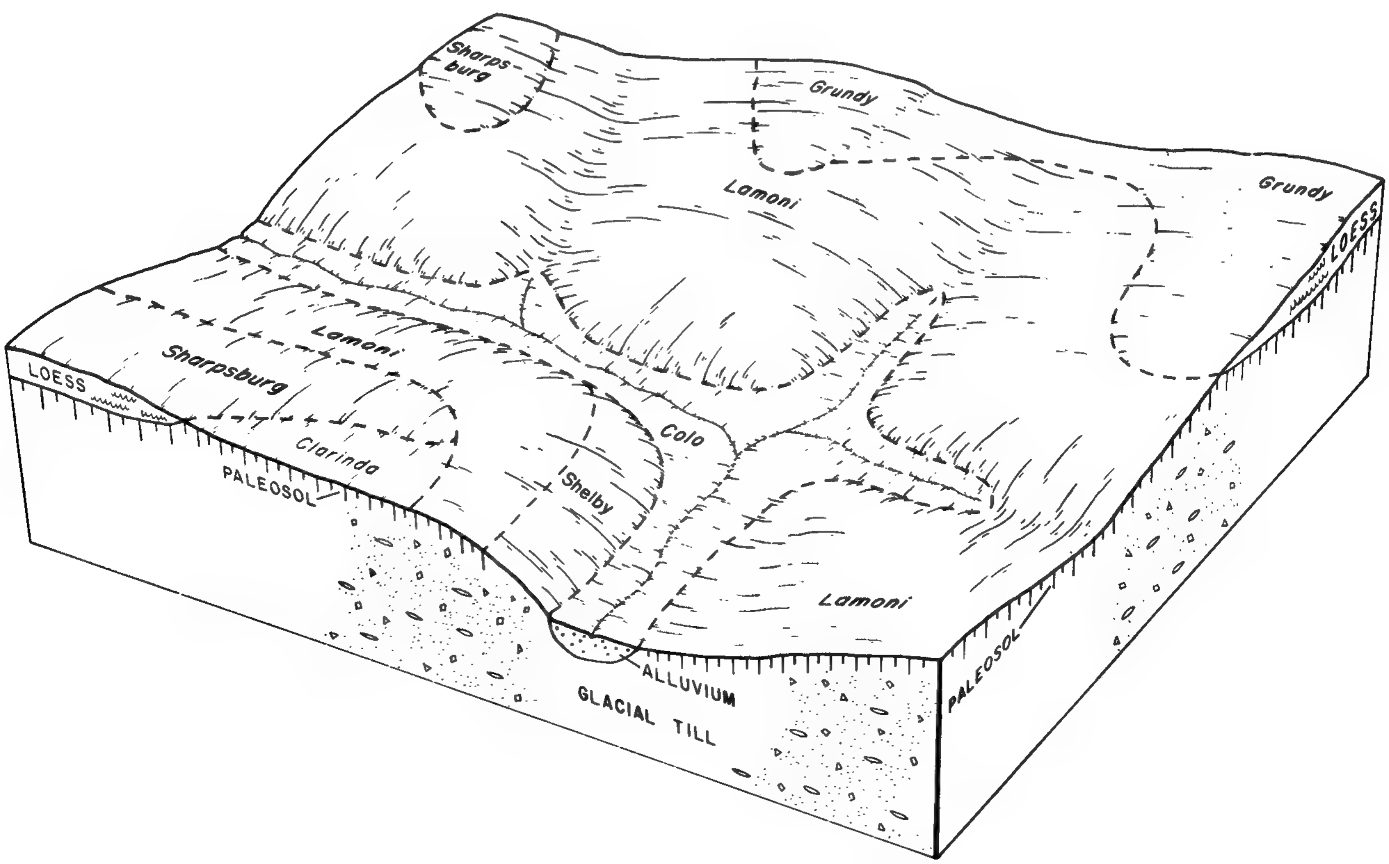


Figure 4.—Typical pattern of soils and parent material in the Lamoni association.

5. Marshall-Higginsville association

Well drained and somewhat poorly drained soils that formed in loess

This association consists of gently sloping soils on wide ridgetops and moderately sloping soils on side slopes that are dissected by narrow, branching drainageways (fig. 6).

This association makes up about 4 percent of the county. It is about 38 percent Marshall soils, 31 percent Higginsville soils, and 31 percent minor soils.

Marshall soils are well drained and are on wide ridgetops and convex side slopes. Their surface layer is very dark brown silt loam, and the subsurface layer is very dark brown silty clay loam. The subsoil is brown and yellowish brown silty clay loam. The substratum is yellowish brown, mottled silty clay loam.

Higginsville soils are somewhat poorly drained and are on concave side slopes. Their surface layer is black silt loam, and the subsurface layer is very dark gray silty clay loam. The subsoil is dark grayish brown and grayish brown, mottled silty clay loam. The substratum is grayish brown, mottled silty clay loam.

The minor soils are the more clayey Lamoni soils on side slopes at a lower elevation than the Higginsville soils, the moderately well drained Shelby soils on side slopes at a lower elevation than the Lamoni soils, and the poorly drained Colo soils on narrow drainageways.

The soils in this association are used mainly for cultivated crops, hay, and pasture. The soils are suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes for hay and pasture. Slope and the hazard of erosion are the main management concerns. Surface wetness is a problem on Higginsville soils in spring and fall when tillage and harvesting are done. Overgrazing and grazing when the soil is wet are the major concerns in pasture management.

The soils in this association are suitable for sanitary facilities and building site development if proper design and installation procedures are used. The shrink-swell potential is a moderate limitation. Wetness is a moderate to severe limitation on the Higginsville soils.

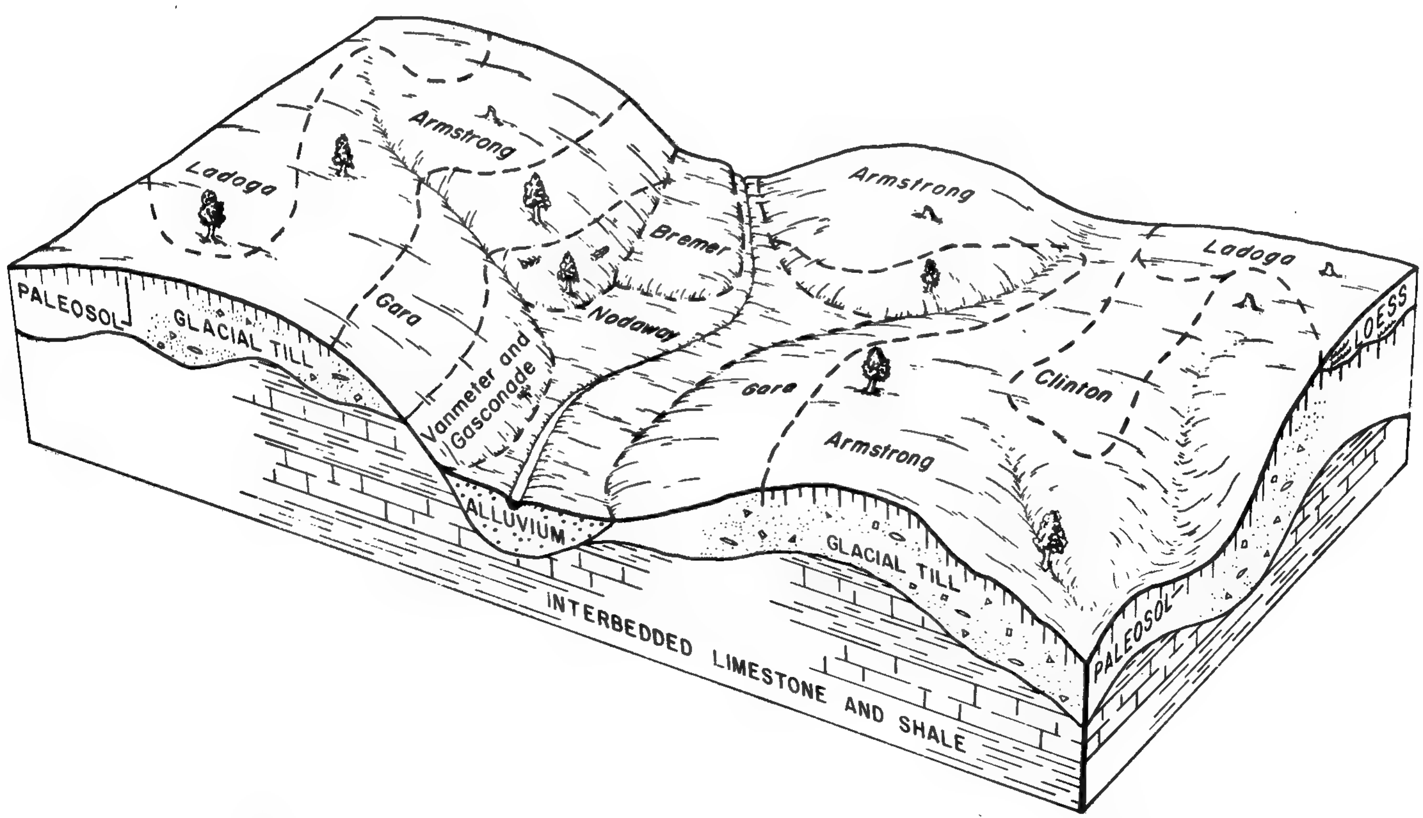


Figure 5.—Typical pattern of soils and parent material in the Armstrong-Gara-Ladoga association.

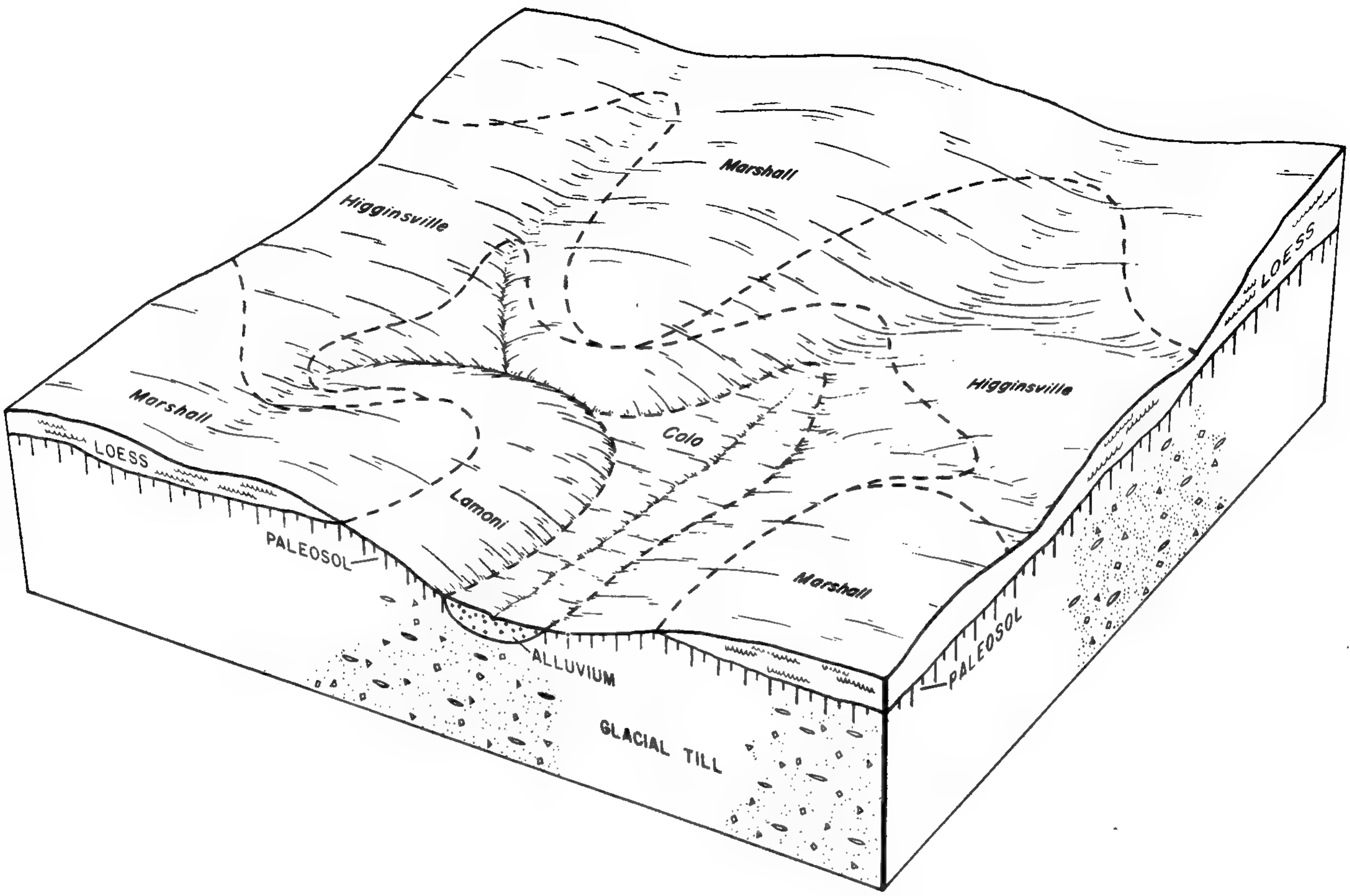


Figure 6.—Typical pattern of soils and parent material in the Marshall-Higginsville association.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and identifies the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Armstrong loam, 5 to 9 percent slopes, is one of several phases in the Armstrong series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Vanmeter-Gasconade complex, 14 to 50 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimilar soils are described in each map unit.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarry, is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

1B—Marshall silt loam, 2 to 5 percent slopes. This is a deep, gently sloping, well drained soil on ridgetops. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 9 inches thick. The subsurface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsoil is about 33 inches thick. The upper part is dark brown and brown, friable silty clay loam, and the lower part is yellowish brown, mottled, friable silty clay loam. The substratum to a depth of 72 inches is yellowish brown, mottled, friable silty clay loam. In some places, the upper part of the subsoil has grayish brown mottles. In some places, the very dark brown surface soil is more than 24 inches thick.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

This soil is used mainly for row crops. It is suited to corn, soybeans, small grains, and grasses and legumes in rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. Most areas of this soil are too narrow to manage independently, but they can be included with areas of adjacent soils in terrace systems and contour farming

operations. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Septic tank absorption fields generally function adequately. Low strength, frost action, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Proper drainage using side ditches and culverts helps prevent damage by frost action and from the shrinking and swelling of the soil.

This soil is in capability subclass IIe.

1C—Marshall silt loam, 5 to 9 percent slopes. This is a deep, moderately sloping, well drained soil on ridgetops and convex side slopes. Individual areas are irregular in shape and range from 10 to 180 acres in size.

Typically, the surface layer is black, friable silt loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 4 inches thick. The subsoil, to a depth of 63 inches, is dark brown, firm silty clay loam in the upper part; dark yellowish brown, mottled, firm silty clay loam in the middle part; and yellowish brown, mottled, firm silty clay loam in the lower part. In a few small areas, the upper part of the subsoil has grayish brown mottles. In several small areas, the surface soil is less than 10 inches thick.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suitable for building site development and for onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Slope is a moderate limitation for small commercial buildings. However, the soil can be leveled in preparing a foundation. Septic tank absorption fields generally function adequately in this soil. Low strength, frost action, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Proper drainage using side ditches and culverts helps prevent damage by frost action and from the shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

5C2—Clinton silt loam, 5 to 9 percent slopes, eroded. This is a deep, moderately sloping, moderately well drained soil on narrow convex ridgetops and side slopes near large streams. Individual areas are narrow in shape and range from 10 to 60 acres in size.

Typically, the surface layer is dark brown silt loam about 6 inches thick. The subsoil is about 37 inches thick. The upper part is dark brown, firm silty clay loam; the middle part is dark yellowish brown, firm silty clay loam; and the lower part is yellowish brown, mottled, firm silty clay loam. The substratum to a depth of 74 inches is yellowish brown and light brownish gray, firm silty clay loam. In some places, the surface layer is very dark grayish brown and is more than 6 inches thick. In some places, the soil is strongly sloping. On a few broad ridgetops, it is gently sloping.

Permeability is moderately slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is high, and the content of organic matter is low. The surface layer is friable and is easily tilled within a wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

This soil is used mainly for hay and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes generally grow well on this soil if adequate fertility is maintained. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees. In a few small areas it is in native hardwoods. No hazards or limitations affect planting or harvesting.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Slope is a limitation for small commercial buildings. However, the soil can be leveled to prepare a foundation. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing the site. In some areas the bottom of the lagoon needs to be sealed to prevent seepage. Local roads and streets should be strengthened with crushed rock or other suitable base material to compensate for the low strength. Proper drainage, including side ditches and culverts, helps prevent damage caused by the shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

7B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This is a deep, gently sloping, moderately well drained soil on convex ridgetops. Individual areas are long and narrow; lateral side ridges are common. The areas are 5 to several hundred acres in size.

Typically, the surface layer is black, friable silty clay loam about 12 inches thick. The subsurface layer is very dark brown, firm silty clay loam about 4 inches thick. The subsoil is about 37 inches thick. The upper part is dark brown, firm silty clay loam; the middle part is dark yellowish brown, mottled, firm silty clay loam; and the lower part is yellowish brown, mottled, firm silty clay loam. The substratum to a depth of 75 inches is mottled, grayish brown and yellowish brown silty clay loam. In some places, the black and very dark brown surface soil is less than 10 inches thick. In some areas, the upper part of the subsoil has grayish brown mottles.

Permeability is moderately slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. Most areas of this soil are too narrow to manage independently. The areas can be included with areas of adjacent soils in terrace systems and contour farming operations. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Because of the moderate permeability in the lower part of the subsoil, septic tank absorption fields generally do not function adequately unless the size of the absorption field is increased. Properly constructed sewage lagoons function adequately, although slope and seepage are limitations. The soil can be leveled in preparing a lagoon site. In some areas the bottom of the lagoon needs to be sealed to prevent seepage. Low strength, frost action, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Proper drainage using side ditches and culverts helps prevent damage caused by frost action and the shrinking and swelling of the soil.

This soil is in capability subclass IIe.

7C—Sharpsburg silty clay loam, 5 to 9 percent slopes. This is a deep, moderately sloping, moderately well drained soil on narrow convex ridgetops and in areas downslope from the end of the ridges. Most areas range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 13 inches thick. The subsoil is about 29 inches thick. The upper part of the subsoil is dark brown and dark yellowish brown, firm silty clay loam; the middle part is dark brown, mottled, firm silty clay loam; and the lower part is dark grayish brown, mottled, firm silty clay loam. The substratum to a depth of 60 inches is mottled, brown and dark brown, firm silty clay loam. In several areas, the very dark grayish brown surface soil is less than 10 inches thick. In some areas, the upper part of the subsoil has grayish brown mottles.

Permeability is moderately slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. Most areas of this soil can be included with areas of adjacent soils in terrace systems and contour farming operations. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pastures reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Slope is a limitation for small commercial buildings. However, the soil can be leveled. Because of the moderate permeability in the lower part of the subsoil, septic tank absorption fields generally do not function adequately unless the size of the absorption field is increased. Sewage lagoons function adequately, although slope is a severe limitation. The soil can be leveled in preparing the lagoon site. In some areas the bottom of the lagoon needs to be sealed to prevent seepage. Low strength, frost action, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Proper drainage using side ditches and culverts helps prevent damage caused by frost action and the shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

8C—Higginsville silt loam, 5 to 9 percent slopes. This is a deep, moderately sloping, somewhat poorly drained soil on side slopes and concave areas on the upper part of drainageways. Individual areas generally are crescent shaped and range from 5 to 160 acres in size.

Typically, the surface layer is about 9 inches thick. It is black, friable silt loam. The subsurface layer is about 4 inches thick. It is very dark gray, friable silty clay loam. The subsoil is about 28 inches thick. The upper part is dark grayish brown, mottled, firm silty clay loam, and the lower part is grayish brown, mottled silty clay loam. The substratum to a depth of 66 inches is grayish brown, mottled silty clay loam. In several small places, the black and very dark gray surface soil is less than 10 inches thick. In some areas, some sand and small pebbles are mixed with the underlying material.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a moderate range of moisture content. The shrink-swell potential of the subsoil is moderate. A perched water table, at a depth of 1.5 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing

by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage by excessive wetness. Slope is a limitation for small commercial buildings. However, the soil can be leveled. Septic tank absorption fields generally do not function adequately because of a seasonal high water table. Properly constructed sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing a lagoon site. In some areas the bottom of the lagoon needs to be sealed to prevent contamination of ground water. Low strength, frost action, wetness, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by frost action, wetness, and the shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

13—Haig silt loam. This is a deep, nearly level, poorly drained soil on broad ridgetops. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is black, friable silt loam about 10 inches thick. The subsurface layer is black, friable silty clay loam about 5 inches thick. The subsoil is about 43 inches thick. The upper part is very dark gray, mottled, firm silty clay; the middle part is olive gray and grayish brown, mottled, firm silty clay; and the lower part is grayish brown, mottled, firm silty clay loam. The substratum to a depth of 74 inches is grayish brown, mottled silty clay loam. In some places, the upper part of the subsoil is dark grayish brown.

Permeability is slow, and surface runoff is very slow. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a fairly narrow range of moisture content. However, it puddles easily if worked when wet. The shrink-swell potential of the subsoil is high. A perched water table, near the surface to as much as 1 foot below, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes. Wetness caused by poor internal drainage is the only significant limitation. Land grading improves surface drainage in ponded areas. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Overgrazing of pastures reduces future production of grasses and legumes and increases weed growth. Pasture and hay mixtures should include wetness-tolerant varieties. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition. Surface drainage using small ditches and land grading help prevent damage to perennial plants by frost action.

This soil is suited to building site development and to onsite waste disposal. However, the high shrink-swell potential of the subsoil and a seasonal high water table are limitations. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage by wetness. Properly constructed sewage lagoons function adequately. Low strength, frost action, the high shrink-swell potential, and wetness are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Proper drainage using side ditches and culverts and a raised, well-compacted subgrade help prevent damage by frost action, the shrinking and swelling of the soil, and wetness.

This soil is in capability subclass IIw.

14B—Grundy silt loam, 2 to 5 percent slopes. This is a deep, gently sloping, somewhat poorly drained soil on convex ridgetops and in broad concave upland areas. Individual areas are irregular in shape and range from about 20 to more than 1,000 acres in size.

Typically, the surface layer is black, friable silt loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 4 inches thick. The subsoil is about 35 inches thick. In the upper part it is very dark gray, firm silty clay loam; in the middle part it is dark grayish brown and grayish brown, mottled firm silty clay; and in the lower part it is olive gray, firm silty clay loam. The substratum to a depth of 74 inches is grayish brown and light brownish gray, mottled silty clay loam. In some areas the surface soil has eroded and is less than 10 inches thick. In other small areas, sand is in the lower part of the subsoil. In some places, the subsoil is silty clay loam throughout.

Permeability is slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming

practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grain, and grasses and legumes in rotation (fig. 7 and fig. 8). Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage by the excessive wetness. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing the lagoon site. Low strength, frost action, the high shrink-swell potential, and wetness are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by frost action, the shrinking and swelling of the soil, and wetness.

This soil is in capability subclass IIe.

14B2—Grundy silty clay loam, 2 to 5 percent slopes, eroded. This is a deep, gently sloping, somewhat poorly drained soil in broad concave upland areas and on some narrow ridges near large streams. Individual areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsoil is about 39 inches thick. The upper part is dark grayish brown and grayish brown, mottled, firm silty clay loam; the middle part is mottled, grayish brown and yellowish brown, firm silty clay; and the lower part is mottled, grayish brown and light brownish gray, firm silty clay loam. The substratum to a depth of 60 inches is light brownish gray, mottled, firm silty clay loam. In some places, the surface layer is more than 10 inches thick. In a few places there are sand and small pebbles in the lower part of the subsoil.

Included with this soil in mapping are some small areas where the original surface layer and the upper part of the subsoil have been removed by erosion and the present surface layer is grayish brown and yellowish brown silty clay.

Permeability is slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is high, and the content of organic matter is moderate. The surface layer is sticky when wet. Tillage is difficult except under optimum moisture conditions. The subsoil has a high shrink-swell potential. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. If the soil is used for cultivated crops, the risk of further erosion is high. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. If the clayey subsoil is exposed by terracing, tillage is difficult, fertility and the available water capacity are decreased, and special management practices may be needed. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation

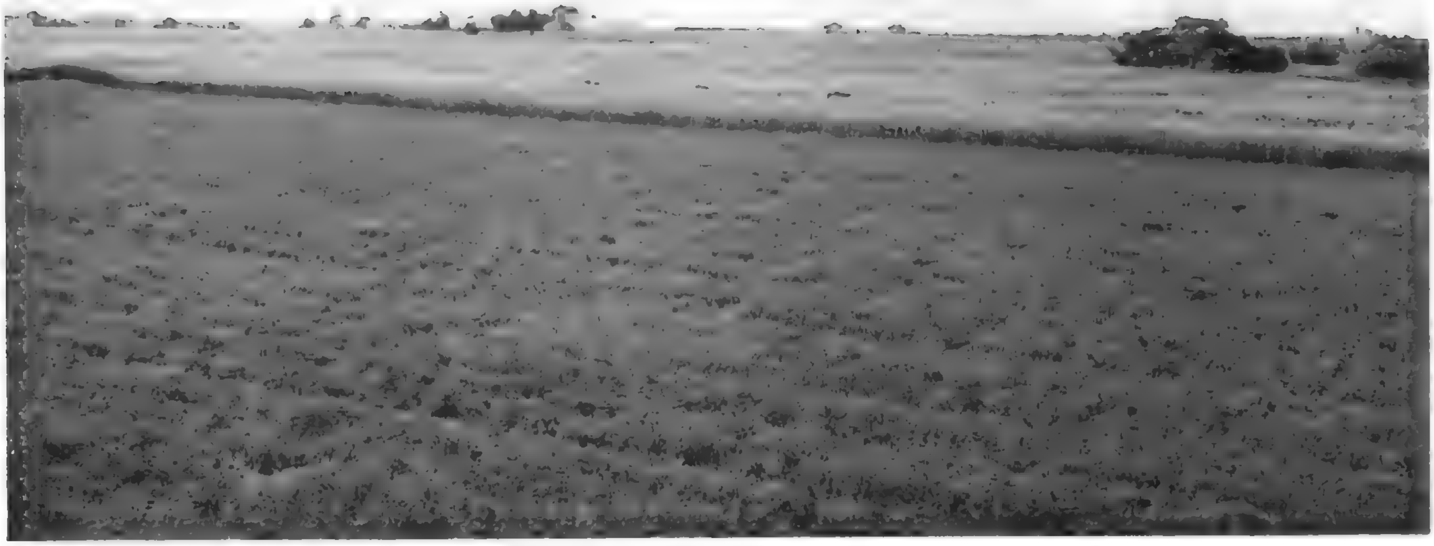


Figure 7.—Grass-legume hay, in the foreground, and wheat, in the background, produce good yields on Grundy silt loam, 2 to 5 percent slopes.

Figure 8.—Soybeans on Grundy silt loam, 2 to 5 percent slopes. Conservation practices are needed on this soil to help prevent erosion.

procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage from the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage by excessive wetness. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing the lagoon site. Low strength, frost action, the high shrink-swell potential, and wetness are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage by frost action, the shrinking and swelling of the soil, and wetness.

This soil is in capability subclass IIIe.

14C—Grundy silt loam, 5 to 9 percent slopes. This is a deep, moderately sloping, somewhat poorly drained soil on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is black, friable silt loam about 8 inches thick. The subsurface layer is black, friable silty clay loam about 5 inches thick. The subsoil is about 28 inches thick. The upper part is very dark gray, firm silty clay loam; the middle part is dark grayish brown, mottled, firm silty clay; and the lower part is grayish brown, mottled, firm silty clay. The substratum to a depth of 70 inches is grayish brown, mottled, firm silty clay. In some places, small pebbles are in the subsoil. In several large areas, the black surface soil is less than 10 inches thick.

Permeability is slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. If the clayey subsoil is exposed by terracing, tillage is difficult, fertility and available water capacity are low, and in places special management is needed. Returning crop residue to the soil or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pastures reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage caused by wetness. Slope is a moderate limitation for small commercial buildings. However, the soil can be leveled in preparing a foundation. Sewage lagoons function adequately if the soil is leveled. Low strength, frost action, the high shrink-swell potential, and wetness are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage by frost action, the shrinking and swelling of the soil, and wetness.

This soil is in capability subclass IIIe.

14C2—Grundy silty clay loam, 5 to 9 percent slopes, eroded. This is a deep, moderately sloping, somewhat poorly drained soil on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsoil is about 42 inches thick. The upper part is dark grayish brown, firm silty clay loam; the middle part is dark grayish brown, mottled, firm silty clay; and the lower part is grayish brown, mottled, firm silty clay loam. The substratum to a depth of 66 inches is gray, mottled clay. In some places, the subsoil has small pebbles. In a few places, the black surface layer is more than 10 inches thick.

Included with this soil in mapping are some soils in small areas on the upper shoulders of side slopes. In those areas, the original surface soil and upper part of the subsoil have been removed by erosion, and the present surface layer is dark grayish brown, firm silty clay. The included soils make up about 5 to 10 percent of the map unit.

Permeability is slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming

practices. Natural fertility is medium, and the content of organic matter is moderate. The surface layer is sticky when wet. Tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Further erosion is a severe hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. If the clayey subsoil is exposed by terracing, tillage is difficult, fertility and the available water capacity are low, and in places special management is needed. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses amd legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. The soil needs to be leveled in preparing a foundation for small commercial buildings, or buildings can be designed to conform to the slope. Drainage tile around footings helps prevent damage caused by excessive wetness. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing a lagoon site. Low strength, frost action, the high shrink-swell potential, and wetness are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by frost action, the shrinking and swelling of the soil, and wetness.

This soil is in capability subclass IIIe.

16B—Ladoga silt loam, 2 to 5 percent slopes. This is a deep, gently sloping, moderately well drained soil on ridgetops near large streams. Individual areas are narrow and have a few lateral side ridges and range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 7 inches thick. The subsoil is about 48 inches thick. The upper part is dark yellowish brown, friable to firm silty clay loam; the lower part is dark yellowish brown, mottled, firm silty clay loam. The substratum is yellowish brown, mottled silty clay loam to a depth of 65 inches. In some places, the surface layer is more than 10 inches thick. In other small places, the upper part of the surface layer is dark brown or grayish brown. In some places, the subsoil has sand and small pebbles. In some places, the upper part of the subsoil is grayish brown.

Permeability is moderately slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is high, and the content of organic matter is moderate. The surface layer is very friable and is easily tilled within a fairly wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. Most areas of this soil are too narrow to manage independently but can be included with areas of adjacent soils in terrace systems and contour farming operations. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees. In a few small areas it is in native hardwoods. Plant competition is a management concern. Careful and thorough site preparation, including spraying or cutting, reduces competition. There are no other hazards or limitations in planting or harvesting trees.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings

can be designed and reinforced to prevent structural damage caused by shrinking and swelling of the subsoil. Sewage lagoons function adequately, although seepage and slope are limitations. The soil can be leveled in preparing a lagoon site. In places the bottom of the lagoon needs to be sealed to prevent seepage. Low strength, frost action, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material is needed for local roads and streets to compensate for low strength. Proper drainage, including side ditches and culverts, helps prevent damage caused by frost action and the shrinking and swelling of the soil.

This soil is in capability subclass IIe.

16C—Ladoga silt loam, 5 to 9 percent slopes. This is a deep, moderately sloping, moderately well drained soil on ridgetops and side slopes near large streams. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 7 inches thick. The subsoil is about 48 inches thick. The upper part is dark yellowish brown, firm silty clay loam. The lower part is dark yellowish brown and grayish brown, firm silty clay loam. The substratum to a depth of 65 inches is yellowish brown, mottled, firm silty clay loam. In a few places, the surface layer is more than 10 inches thick. In other small areas, the surface layer is dark brown or dark grayish brown. In some places, the subsoil has sand and small pebbles and some grayish brown mottles in the upper part.

Permeability is moderately slow, and surface runoff is medium. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is medium, and the content of organic matter is moderate. The surface layer is friable and is easily tilled within a fairly wide range of moisture conditions. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees. In a few areas it is in native hardwoods. Plant competition is a management concern. Careful and thorough site preparation, including spraying or cutting, reduces competition. There are no other hazards or limitations in planting or harvesting trees.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage caused by shrinking and swelling of the subsoil. Slope is a moderate limitation for small commercial buildings. However, the soil can be leveled in preparing a foundation. Sewage lagoons function adequately, although slope and seepage are limitations. The soil can be leveled in preparing a lagoon site. In places the bottom of the lagoon needs to be sealed to prevent seepage. Low strength, frost action, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Proper drainage, including side ditches and culverts, helps prevent damage caused by frost action and the shrinking and swelling of the soil.

This soil is in capability subclass IIIe.

22—Wiota silt loam. This is a deep, nearly level, moderately well drained soil on stream terraces near large streams. It is subject to rare flooding. Individual areas are slightly elongated in shape and range from 6 to 40 acres in size.

Typically, the surface layer is black and very dark grayish brown, friable silt loam about 13 inches thick. The subsurface layer is very dark grayish brown, firm silty clay loam about 7 inches thick. The subsoil extends to a depth of about 60 inches. It is dark brown, firm silty clay loam in the upper part and grayish brown, mottled, firm silty clay loam in the lower part. In some places, the upper part of the subsoil has dark grayish brown mottles. In several small areas, the surface soil is less than 18 inches thick. In some narrow areas around the perimeter of the terraces, the soil is gently to moderately sloping.

Included with this soil in mapping are a few small areas of poorly drained Bremer soils and somewhat poorly drained Nevin soils. These soils are in slightly lower positions and make up less than 10 percent of the map unit.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within

a wide range of moisture content. The shrink-swell potential of the subsoil is moderate. Flooding is rare in most areas.

In most areas this soil is used for row crops. It is suited to corn, soybeans, small grains, and grasses and legumes. It has no significant limitations for agricultural production if it is protected from flooding and runoff from adjacent upland soils. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing a pasture reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil generally is not suitable for building site development because of the rare flooding. Dwellings can be located on adjacent upland areas. If this soil is used for building site development, previous flooding should be considered.

This soil is in capability class I.

23—Bremer silty clay loam. This is a deep, nearly level, poorly drained soil on low stream terraces near large streams. It is subject to rare flooding. Individual areas are slightly elongated in shape and range from 10 to 70 acres in size.

Typically, the surface layer is black, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 8 inches thick. The subsoil is about 39 inches thick. The upper part is black, firm silty clay loam; the middle part is very dark gray and dark gray, mottled, firm silty clay loam; and the lower part is gray, mottled, firm silty clay loam. The substratum to a depth of about 66 inches is gray, mottled, firm silty clay loam.

Included with this soil in mapping are several areas of somewhat poorly drained Nevin soils. These soils are in slightly higher positions and make up about 5 to 10 percent of the map unit.

Permeability is moderately slow. Surface runoff is slow. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is high, and the content of organic matter is very high. The surface layer is friable and is easily tilled within a fairly narrow range of moisture content. It puddles easily if worked when wet. The shrink-swell potential of the subsoil is high. A high water table, at a depth of 1 to 2 feet, is common during extended wet periods. Flooding is rare in most areas.

In most areas this soil is used for row crops. In a few areas it is used as woodland. This soil is suited to corn, soybeans, small grains, and grasses and legumes. Wetness caused by runoff from upland soils and poor internal drainage are the main limitations for agricultural production. Diversions help control runoff from the uplands. Land grading improves surface drainage in ponded areas. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

A pasture and hay mixture that includes wetness-tolerant varieties is necessary on this soil. Overgrazing the pasture reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition. Surface drainage by small ditches and land grading help prevent damage to perennial plants caused by frost action.

This soil is suited to trees. In some areas it is in native hardwoods. Equipment limitation, plant competition, seedling mortality, and windthrow are management concerns. Equipment operations should be done when the soil is dry or frozen. Plant competition can be reduced by careful and thorough site preparation, including spraying or cutting. Planting special stock that is larger than usual and ridging the soil before planting increases the chance of survival. Light, frequent thinnings to reduce stand density help minimize windthrow damage.

This soil generally is not suitable for building site development because of the rare flooding. Dwellings should be constructed in adjacent upland areas. If this soil is used for building site development, previous flooding should be considered.

This soil is in capability subclass IIw.

24—Nevin silt loam. This is a deep, nearly level, somewhat poorly drained soil on stream terraces near large streams. It is subject to rare flooding. Individual areas are slightly elongated in shape and range from 6 to 120 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 9 inches thick. The subsurface layer also is very dark grayish brown, friable silt loam about 9 inches thick. The subsoil is about 33 inches thick. The upper part is dark grayish brown, friable silty clay loam; the middle part is dark grayish brown and grayish brown, mottled, firm silty clay loam; and the lower part is grayish brown, mottled, firm silty clay loam. The substratum to a depth of 65 inches is grayish brown, mottled, firm silty clay loam. In several small areas and in a few large areas, the surface and subsurface layers are less than 18 inches thick, and the subsoil is black or very dark gray and has more clay. In a few small areas

the subsurface layer is dark grayish brown or grayish brown.

Included with this soil in mapping are a few areas of poorly drained Bremer soils. These soils are in slightly lower positions and make up 5 to 10 percent of the map unit.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a moderate range of moisture content. The shrink-swell potential of the subsoil is moderate. A high water table, at a depth of 2 to 4 feet, is common during extended wet periods. Flooding is rare in most areas.

In most areas this soil is used for crops. It is suited to corn, soybeans, small grains, and grasses and legumes. It has no significant limitations for agricultural production if it is protected from flooding and runoff from adjacent upland soils. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing the pasture reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil generally is not suitable for building site development because of the rare flooding. Dwellings should be constructed on the adjacent uplands. If this soil is used for building site development, previous flooding should be considered.

This soil is in capability class I.

26D—Vanmeter silt loam, 9 to 14 percent slopes. This is a moderately deep, strongly sloping, moderately well drained soil on lower side slopes of narrow dissected ridges. The areas are irregular in shape and range from 15 to 100 acres in size.

Typically, the surface layer is dark brown silt loam about 6 inches thick. The subsoil is about 28 inches thick. The upper part is dark yellowish brown, mottled, firm silty clay loam; the middle part is yellowish brown and strong brown, mottled, firm silty clay; and the lower part is light olive brown, mottled, firm silty clay. The substratum to a depth of 50 inches is light olive brown and olive, mottled, calcareous, very firm platy clay shale. In a few places, the dark surface layer is more than 10 inches thick. In a few areas the soil is more than 36 inches deep to shale.

Included with this soil in mapping are several small areas and a few large areas of Armstrong and Gara soils on the upper part of slopes. Also included are some small areas of rock outcrop on lower slopes. The included areas make up about 15 percent of the map unit.

Permeability is very slow. Surface runoff is rapid. The available water capacity is moderate. Natural fertility and the content of the organic matter are low. The shrink-swell potential of the subsoil is high.

In most areas this soil is used for pasture, hay, and trees. It is suited to hay and pasture. This soil generally is not suitable for row crops because of the low natural fertility and the moderate available water capacity. It should be tilled only as needed for pasture seeding. Minimum tillage in establishing or reseeding grasses and legumes helps prevent excessive soil loss.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes moderately deep-rooted varieties grows best on this soil if an adequate level of fertility is maintained. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. However, expected production of commercial timber is low and generally does not justify the management required.

This soil is suitable for building site development if proper design and installation procedures are used. In the steeply sloping areas exposed during construction, it is difficult to establish a plant cover and divert runoff away from the foundation. In places the weathered shale bedrock underlying the subsoil increases the cost of basement excavation. Basement walls, foundations, and footings for dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Sewage lagoons function adequately. In places extra soil material is needed to construct the berms. Careful design and leveling are needed to compensate for the steep slope. Sewage can be piped to adjacent areas where the soil is more suitable for lagoons. Low strength, the high shrink-swell potential, slope, and frost action are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Proper drainage using side ditches and culverts helps prevent damage caused by the shrinking and swelling of the soil and frost action. Cutting and filling are needed in some areas, or roads can be designed to fit the slope.

This soil is in capability subclass VIe.

29F—Vanmeter-Gasconade complex, 14 to 50 percent slopes. These are moderately deep and shallow, moderately steep to very steep, moderately well drained and somewhat excessively drained soils. They are in areas adjacent to stream benches and flood plains. The areas are narrow, long, and irregular in shape. They range from 100 to 700 feet in width and from one-fourth of a mile to several miles in length.

Vanmeter soil makes up about 17 to 76 percent of the map unit and Gasconade soil 15 to 65 percent. The Gasconade soil is on the upper part of the slopes, and the Vanmeter soil is on the middle and lower parts. Areas of these soils generally are too narrow to be mapped separately.

Typically, the surface layer of the Vanmeter soil is very dark grayish brown silty clay loam about 3 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown silty clay loam and dark yellowish brown, firm silty clay, and the lower part is olive brown and yellowish brown, firm silty clay. The substratum is olive gray silty clay about 14 inches thick. It is underlain by soft shale. In some places, the dark surface layer is more than 10 inches thick.

Typically, the surface layer of the Gasconade soil is black, flaggy silty clay loam about 4 inches thick. The subsoil is 14 inches thick. The upper part is very dark grayish brown, firm, flaggy silty clay, and the lower part is dark brown, firm, flaggy silty clay. Hard, fractured limestone bedrock is at a depth of 18 inches.

Included with these soils in mapping, and making up 5 to 10 percent of the map unit, are well drained, deep, flaggy soils in areas between the Gasconade and Vanmeter soils. Also included are deep, gravelly and loamy, well drained soils on the lower part of the slopes. These soils make up less than 5 percent of the unit. Also included are small areas of deep Gara soils. Gara soils are at a higher elevation than Gasconade and Vanmeter soils and make up less than 5 percent of the map unit.

The Vanmeter soil has very slow permeability, and the Gasconade soil has moderately slow permeability. Surface runoff is rapid on both soils. The available water capacity of the Vanmeter soil is moderate, and that of the Gasconade soil is very low. The content of organic matter is low in the Vanmeter soil and moderate in the Gasconade soil. Natural fertility is low for both soils. The shrink-swell potential is high for the Vanmeter soil and moderate for the Gasconade soil.

In most areas these soils are used as woodland. Onsite investigation is needed to determine the feasibility of intensive timber management. The included deep soils are more productive than the Vanmeter and Gasconade soils.

These soils generally are not suited to building site development, sanitary facilities, and local roads and streets because of the steep slopes (fig. 9) and the shallowness of the Gasconade soil.

The Vanmeter soil is in capability subclass VIIe and the Gasconade soil in subclass VIIs.

33C—Armstrong loam, 5 to 9 percent slopes. This is a deep, moderately sloping, somewhat poorly drained soil on ridges and side slopes near large streams and their tributaries. Individual areas are irregular in shape and range from 5 to 240 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsoil extends to a depth of 72 inches. The upper part is brown, mottled, firm clay loam; the middle part is brown, mottled, firm clay; and the lower part is mottled, strong brown and gray, firm clay loam. In some convex areas, the upper part of the subsoil does not have gray mottles. In places, the subsoil does not have sand and small pebbles. In some small areas, slopes are less than 5 percent. In some areas, the surface layer is thinner because of erosion.

Permeability is slow, and surface runoff is medium. The available water capacity is moderate. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is medium, and the content of organic matter is moderate. The surface layer is friable and is easily tilled within a fairly narrow range of moisture content. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. In some areas it is used as woodland. This soil is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Erosion is a hazard if the soil is used for cultivated corps. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Where the clayey subsoil is exposed by terracing, tillage is difficult, fertility and the available water capacity are low, and special management may be needed. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. In a few small areas it is in

Figure 9.—This road cut in an area of Vanmeter-Gasconade complex, 14 to 50 percent slopes, exposes the material that underlies the shallow Gasconade soil.

native hardwoods. Seedling mortality and windthrow are management concerns. Planting special stock that is larger than usual increases chances of survival. Light, frequent thinnings to reduce stand density help minimize windthrow damage.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Slope is a limitation for small commercial buildings. However, the soil can be leveled in preparing a foundation. Drainage tile around footings helps prevent damage caused by excessive wetness. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing a lagoon site. Low strength, frost action, the high shrink-swell potential, and wetness are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by frost action, the shrinking and swelling of the soil, and wetness.

This soil is in capability subclass IIIe.

33D—Armstrong clay loam, 9 to 14 percent slopes. This is a deep, strongly sloping, somewhat poorly

drained soil on side slopes near large streams and their tributaries. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil extends to a depth of 60 inches. The upper part is dark brown, mottled, firm clay; the middle part is yellowish brown, mottled, firm clay; and the lower part is yellowish brown, mottled, firm clay loam. In some places, the upper part of the subsoil does not have mottles.

Included with this soil in mapping are some small areas where erosion has removed the original surface layer and the present surface layer is brown clay. The included areas make up about 5 percent of the map unit.

Permeability is slow, and surface runoff is rapid. The available water capacity is moderate. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is low, and the content of organic matter is moderate. The surface layer is friable and is easily tilled within a fairly narrow range of moisture content. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for hay and pasture. In some areas it is used as woodland. This soil is suited to use for hay and pasture. Row crops and small grains are suitable only on a limited basis using contour farming and a proper crop rotation. Erosion is a severe hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Construction of grassed backslope terraces reduces the steepness of the slope. If row crops are grown, grassed backslope terraces are more desirable than conventional terraces. Special management is needed in some areas where terracing has exposed the clayey subsoil. In these areas the soil is difficult to till. Fertility and the available water capacity are low. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. In a few small areas it is in native hardwoods. Seedling mortality and windthrow are management concerns. Planting special stock that is larger than usual increases chances of survival. Light, frequent thinnings to reduce stand density help minimize windthrow damage.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for dwellings built on this soil can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Dwellings can be designed to accommodate the landscape, or the slope can be altered by land shaping. Drainage tile around footings helps prevent damage caused by excessive wetness. Sewage lagoons function adequately, although slope is a limitation in construction. The soil needs to be leveled, or sewage can be piped to areas of less sloping soils that are more suitable for lagoons. Low strength, frost action, the high shrink-swell potential, wetness, and slope are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by frost action, the shrinking and swelling of the soil, and wetness. Cutting and filling are necessary in some areas, or roads can be designed to fit the slope.

This soil is in capability subclass IVe.

34C3—Armstrong clay loam, 5 to 9 percent slopes, severely eroded. This is a deep, moderately sloping, somewhat poorly drained soil on side slopes near large streams and their tributaries. Individual areas are irregular in shape and range from 6 to 30 acres in size.

Typically, the plow layer consists mostly of subsoil material. It is dark brown clay loam about 5 inches thick. The subsoil is about 35 inches thick. The upper part is yellowish red, mottled, firm clay; the middle part is strong brown, mottled, firm clay; and the lower part is dark yellowish brown, mottled, firm clay. The substratum to a depth of 72 inches is mottled, dark yellowish brown and light brownish gray, firm clay loam. In some small areas, the subsoil does not have sand and small pebbles.

Permeability is slow, and surface runoff is rapid. The available water capacity is moderate. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are low. The surface layer is sticky when wet, and tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to hay and pasture. It is suited to row crops and small grains only on a limited basis, and only if contour farming and a proper crop rotation are used. In

many areas the topsoil has been completely removed by erosion, and the plow layer is mostly clay subsoil material. Further erosion is a severe hazard if this soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectivly control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces plant competition and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting special stock that is larger than usual increases the chance of survival. Light, frequent thinnings to reduce stand density help minimize windthrow.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Drainage tile installed around footings helps prevent damage caused by excessive wetness. Slope is a moderate limitation for small commercial buildings. The soil can be leveled in preparing a foundation. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing a lagoon site. Low strength, frost action, the high shrink-swell potential, and wetness are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by frost action, the shrinking and swelling of the soil, and wetness.

This soil is in capability subclass IVe.

34D3—Armstrong clay loam, 9 to 14 percent slopes, severely eroded. This is a deep, strongly sloping, somewhat poorly drained soil on side slopes near large streams and their tributaries. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the plow layer consists mostly of subsoil material. It is dark brown, mottled, firm clay loam about 3 inches thick. The subsoil extends to a depth of 60 inches. It is strong brown, mottled firm clay. In some places the upper part of the subsoil does not have mottles.

Permeability is slow, and surface runoff is rapid. The available water capacity is moderate. Reaction varies widely in the surface layer because of local liming practices. Natural fertility and the content of organic matter are low. The surface layer is sticky when wet. Tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for hay and pasture. It is suited to hay and pasture. It generally is not suited to use as cropland because nearly all of the surface soil has been removed by erosion. This soil should be tilled only when necessary for pasture seeding. Using minimum tillage in establishing or reseeding grasses and legumes helps prevent excessive soil loss.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows best on this soil if an adequate level of fertility is maintained. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting special stock that is larger than usual increases the chance of survival. Light, frequent thinnings to reduce stand density help minimize windthrow damage.

This soil is suitable for building site development if proper design and installation procedures are used. Basement walls, foundations, and footings for dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Dwellings can be designed to accommodate the landscape, or the slope can be altered by land shaping. Drainage tile around footings helps prevent damage caused by excessive wetness. Sewage lagoons function adequately, but slope is a limitation. The lagoon site can be leveled, or the sewage can be piped to adjacent areas of less sloping soils that are more suitable for lagoons. Low strength, frost action, the high shrink-swell potential, wetness, and slope are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Grading the roads so that they shed water and using side ditches and culverts help prevent damage caused by frost action, the shrinking and swelling of the soil, and

wetness. Cutting and filling are necessary is some areas, or the roads can be designed to fit the slope.

This soil is in capability subclass VIe.

37D—Gara loam, 9 to 14 percent slopes. This is a deep, strongly sloping, moderately well drained soil generally on side slopes adjacent to large streams and their tributaries. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, very friable loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable loam about 3 inches thick. The subsoil is about 41 inches thick. The upper part is yellowish brown, firm clay loam, and the lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of 60 inches is yellowish brown, mottled, calcareous, firm clay loam. In some places, the depth to calcareous clay loam is less than 36 inches. In some places, the dark surface layer has been removed by erosion, and the present surface layer is clay loam. In many small areas, the subsoil is yellowish red clay loam. In several narrow areas, the subsoil is red or yellowish red and does not have glacial sand or pebbles.

Included with this soil in mapping are a few small areas of somewhat poorly drained Armstrong and Lamoni soils. These soils are moderately sloping and strongly sloping and are in adjacent positions higher on the landscape. The included areas make up less than 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is rapid. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is medium, and the content of organic matter is moderate. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for hay and pasture. In some areas it is used as woodland. This soil is suited to hay and pasture. It is suited to row crops and small grains only on a limited basis. Contour farming and a proper crop rotation have to be used. Erosion is a severe hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In some large areas where the soil is smoothly sloping, terracing and contour farming can be used. Grassed backslope terraces reduce the steepness of the slope and in places are more desirable than conventional terraces if row crops are grown. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pastures reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees. In a few small areas it is in native hardwoods. There are no hazards or limitations in planting or harvesting trees.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. If sloping areas are exposed during construction, it is difficult to establish a plant cover in these areas and to divert runoff away from the foundation. Basement walls, foundations, and footings for dwellings can be designed and reinforced to prevent structural damage caused by the swelling of the subsoil. Dwellings can be designed to accommodate the landscape, or the slope can be altered by land shaping. Sewage lagoons function adequately, although slope is a limitation. The soil needs to be leveled, or sewage can be piped to adjacent areas of less sloping soils that are more suitable for lagoons. Low strength, slope, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Cutting and filling are necessary in some areas, or roads can be designed to fit the slope. Side ditches and culverts help prevent damage caused by the shrinking and swelling of the soil and frost action.

This soil is in capability subclass IVe.

37E—Gara loam, 14 to 20 percent slopes. This is a deep, moderately steep, moderately well drained soil generally on side slopes adjacent to large streams and their tributaries. Individual areas are irregular in shape and range from 5 to 150 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsurface layer is dark grayish brown, friable loam about 3 inches thick. The subsoil is about 43 inches thick. The upper part is yellowish brown, firm clay loam, and the lower part is strong brown, mottled, firm clay loam. The substratum to a depth of 72 inches is yellowish brown, firm clay loam. In some places, the surface layer is less than 6 inches thick. In some areas, the subsoil is yellowish red clay loam. In several narrow areas, the subsoil is red or yellowish red and does not have glacial sand and pebbles.

Included with this soil in mapping are a few small areas of the moderately deep Vanmeter soils and the shallow Gasconade soils and rock outcrop. The included areas are on lower slopes adjacent to large

drainageways and make up less than 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is rapid. The available water capacity is high. Natural fertility is medium, and the content of organic matter is moderate. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for pasture and hay and as woodland. It is suited to hay and pasture. It is too steep for use as cropland and should be tilled only as needed for pasture seeding. Timely use of minimum tillage that leaves large amounts of residue on the surface is necessary in order to prevent severe damage from erosion.

Grasses and legumes grown for pasture and hay effectively control erosion. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. In a few areas it is in native hardwoods. Erosion is a hazard, and the use of equipment is limited. Roads and skid trails should be located on the contour to minimize the steepness and length of slopes and prevent concentration of water. After harvesting is completed, some areas need to be seeded. In some areas yarding logs uphill to logging roads or skid trails is required.

This soil is suitable for building site development if proper design and installation procedures are used. In the areas exposed during construction, it is difficult to establish a plant cover and divert runoff away from the foundation. Basement walls, foundations, and footings for dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Although dwellings can be designed to accommodate the slope, some land shaping is generally necessary. Slope is a limitation for sewage lagoons. However, sewage generally can be piped to adjacent areas where the soil is suitable for lagoons. Low strength, slope, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Although roads can be designed to fit the slope, cutting and filling are generally necessary. Using side ditches and culverts for drainage helps prevent damage caused by the shrinking and swelling of the soil and frost action.

This soil is in capability subclass VIe.

39C2—Clarinda silty clay loam, 5 to 9 percent slopes, eroded. This is a deep, moderately sloping, poorly drained soil on side slopes and in concave areas. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is silty clay loam about 9 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil extends to a depth of 64 inches. The upper part is dark gray, mottled, firm clay; the middle part is gray, mottled, very firm clay; and the lower part is gray, mottled, firm clay. In some areas, the subsoil is dark grayish brown. In some places, it does not have sand or small pebbles.

Permeability is very slow, and surface runoff is medium. The available water capacity is moderate. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is medium, and the content of organic matter is moderate. The surface layer is sticky when wet. Tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to hay and pasture. The subsoil commonly is gumbotil and does not provide enough water for healthy crop growth during dry summer months. In dry periods numerous cracks form in the surface layer. Further erosion is a severe hazard if this soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties is necessary on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil generally is not suitable for building site development because of the high shrink-swell potential of the subsoil and a seasonal high water table.

This soil is in capability subclass IVe.

42C—Lamoni silty clay loam, 5 to 9 percent slopes. This is a deep, moderately sloping, somewhat poorly drained soil on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 5 to 160 acres in size.

Typically, the surface layer is about 7 inches thick. It is black, friable silty clay loam. The subsurface layer is about 4 inches thick and is very dark gray, friable clay

loam. The subsoil extends to a depth of 60 inches. The upper part is dark grayish brown, firm clay loam; the middle part is dark grayish brown and grayish brown, mottled, firm clay; and the lower part is grayish brown, mottled, firm clay loam. In some places, at a lower elevation on the landscape, the subsoil is commonly brown and has reddish mottles. In some places, the subsoil does not have sand and small pebbles. In several places, the surface layer and the subsurface layer together are less than 10 inches thick.

Permeability is slow, and surface runoff is medium. The available water capacity is moderate. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is sticky when wet. Tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn soybeans, small grains, and grasses and legumes in a crop rotation. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on the field through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. If the clayey subsoil is exposed by terracing, tilling is difficult, fertility and the available water capacity are low, and in places special management is needed. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings built on this soil can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage caused by excessive wetness. Slope is a limitation for small commercial buildings. However, the soil can be leveled for foundations. Sewage lagoons function adequately, but the lagoon site needs to be leveled. Low strength, the high shrink-swell potential, wetness, and frost action are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by the shrinking and swelling of the soil, wetness, and frost action.

This soil is in capability subclass IIIe.

42C2—Lamoni silty clay loam, 5 to 9 percent slopes, eroded. This is a deep, moderately sloping, somewhat poorly drained soil on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay loam about 6 inches thick. The subsoil extends to a depth of 72 inches. The upper part is dark grayish brown and grayish brown, very firm clay, and the lower part is yellowish brown and grayish brown, very firm clay. In many small areas, the upper part of the subsoil is dark yellowish brown or strong brown and has red mottles. In some small areas, slopes are less than 5 percent.

Included with this soil in mapping are several small and a few large areas where all of the dark surface soil has been removed by erosion and the present plow layer consists mostly of the upper part of the clay subsoil. The included soils are on the upper shoulders of side slopes and make up about 5 to 10 percent of the map unit.

Permeability is slow, and surface runoff is medium. The available water capacity is moderate. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is medium, and the content of organic matter is moderate. The surface layer is sticky when wet. Tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. It is suited to corn, soybeans, small grains, and grasses and legumes in a crop rotation. Further erosion is a severe hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. If the clayey subsoil is exposed by terracing, tillage is difficult, fertility and the available water capacity are low, and special management may be needed. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture

that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage caused by excessive wetness. Slope is a limitation for small commercial buildings. The soil needs to be leveled in preparing a foundation. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled in preparing a lagoon site. Low strength, the high shrink-swell potential, wetness, and frost action are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by the shrinking and swelling of the soil, wetness, and frost action.

This soil is in capability subclass IIIe.

42D—Lamoni silty clay loam, 9 to 14 percent slopes. This is a deep, strongly sloping, somewhat poorly drained soil on side slopes and in concave areas near large drainageways and their tributaries. Individual areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is black, friable silty clay loam about 12 inches thick. The subsoil is about 40 inches thick. The upper part is dark grayish brown, firm clay loam, the middle part is dark grayish brown and grayish brown, mottled, firm clay, and the lower part is yellowish brown and light brownish gray, mottled, firm clay. The substratum to a depth of 65 inches is gray and strong brown, firm, calcareous clay loam. In some places, the dark surface soil is less than 10 inches thick. In other areas, the upper part of the subsoil is yellowish red. In some places, the upper part of the subsoil is brown or dark yellowish brown, and the calcareous clay loam material is at a shallower depth.

Permeability is slow, and surface runoff is rapid. The available water capacity is moderate. Reaction of the surface layer varies widely because of local liming practices. Natural fertility is medium, and the content of organic matter is high. The surface layer is sticky when wet. Tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A perched water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for pasture and hay. In some areas it is used for row crops. This soil is suited to hay and pasture. It is suited to row crops and small grains only on a limited basis. Contour farming and a proper crop rotation are necessary. Erosion is a severe hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In some large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Grassed backslope terraces reduce the steepness of the slope, and in places are more desirable than conventional terraces if row crops are grown. Special management is required in some areas where terracing has exposed the clayey subsoil. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for building site development if proper design and installation procedures are used. Basement walls, foundations, and footings for dwellings can be designed and reinforced to prevent structural damage caused by the shrinking and swelling of the subsoil. Drainage tile around footings helps prevent damage caused by excessive wetness. Sewage lagoons function adequately, although slope is a limitation. The soil needs to be leveled, or sewage can be piped to adjacent areas where the soil is less sloping and more suitable for lagoons. Low strength, the high shrink-swell potential, wetness, slope, and frost action are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for the low strength. Grading roads so that they shed water and using side ditches and culverts help prevent damage caused by the shrinking and swelling of the soil, wetness, and frost action. Cutting and filling are necessary in some places, or roads can be designed to fit the slope.

This soil is in capability subclass IVe.

44D—Shelby loam, 9 to 14 percent slopes. This is a deep, strongly sloping, moderately well drained soil on

side slopes. Individual areas are irregular in shape and range from 5 to 90 acres in size.

Typically, the surface layer is black, friable and very friable loam about 11 inches thick. The subsurface layer is very dark grayish brown, mottled, friable clay loam about 5 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown, firm clay loam; the middle part is dark yellowish brown, firm clay loam; and the lower part is yellowish brown, firm clay loam. The substratum to a depth of 60 inches is yellowish brown, mottled, firm, calcareous clay loam. In many small and a few large areas, the dark surface soil is less than 10 inches thick. In some places, the upper part of the subsoil has grayish brown and red mottles and more clay. In several small areas, the depth to calcareous clay loam is less than 30 inches.

Permeability is moderately slow, and surface runoff is rapid. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility and the content of organic matter are high. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

In most areas this soil is used for hay and pasture. In some areas it is used for row crops. This soil is suited to hay and pasture. It is suited to row crops and small grains only on a limited basis. Contour farming and a proper crop rotation are necessary. Erosion is a severe hazard if the soil is used for cultivated crops. Minimum tillage, stripcropping, winter cover crops, and grassed waterways help prevent excessive soil loss. Leaving crop residue on fields through the winter helps protect the soil from erosive rains. In many large areas the soil is smoothly sloping and can be terraced and farmed on the contour. Grassed backslope terraces reduce the steepness of the slope. They are more desirable than conventional terraces in some places where row crops are grown. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Deep-rooted legumes, alfalfa, for example, grow well on this soil. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if proper design and installation procedures are used. If the soil is exposed by leveling in preparing a building site, it is difficult to establish a vegetative cover and divert runoff away from the foundation. Basement walls, foundations, and footings for dwellings can be designed and reinforced to prevent damage caused by the shrinking and swelling of the subsoil. Sewage lagoons function adequately, although slope is a limitation. The soil can be leveled, or sewage can be piped to adjacent areas where the soil is more suitable for lagoons. Low strength, frost action, and the shrink-swell potential are limitations for local roads and streets. Crushed rock or other suitable base material helps compensate for low strength. Using side ditches and culverts for drainage helps prevent damage caused by frost action and the shrinking and swelling of the soil. Cutting and filling are necessary in some areas, or roads can be designed to fit the slope.

This soil is in capability subclass IIIe.

52—Kennebec silt loam. This is a deep, nearly level, moderately well drained soil on flood plains of medium and large drainageways adjacent to the stream channels. It is subject to occasional flooding. Individual areas are as much as several miles in length, vary in width, and are generally several hundred acres or more in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 10 inches thick. The subsurface layer is black, friable silt loam about 30 inches thick. The substratum to a depth of 63 inches is very dark gray, friable silt loam. In some places, the underlying material is stratified silt loam. In some areas, the underlying material is dark gray or gray silt loam.

Permeability is moderate, and surface runoff is slow. The available water capacity is very high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is high, and the content of organic matter is high. The surface layer is friable and is easily tilled within a wide range of moisture content. The shrink-swell potential is moderate. A high water table, at a depth of 3 to 5 feet, is common during extended wet periods.

In most areas this soil is used for row crops. In many small, narrow areas it is used as woodland and pasture. This soil is suited to corn, soybeans, small grains, and grasses and legumes. It has no significant limitations for agricultural production if it is protected from flooding and runoff from adjacent upland soils. Land grading can make uneven areas easier to farm. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Deep-rooted legumes, alfalfa, for example, grow well on this soil if flooding is very brief. Overgrazing a pasture reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. In several small areas it is in walnut and native hardwoods. Plant competition is a management concern. When trees are planted, careful site preparation, including spraying or cutting in some areas, is necessary. There are no other hazards or limitations in planting and harvesting trees.

This soil generally is not suitable for building site development because of occasional flooding.

This soil is in capability subclass IIw.

55B—Colo silty clay loam, 2 to 5 percent slopes. This is a deep, gently sloping, poorly drained soil in low concave areas in small upland drainageways. It is subject to occasional flooding. Individual areas are long and narrow, commonly branching toward the uplands. The areas range from 10 to several hundred acres in size.

Typically, the surface layer is black, friable silty clay loam about 10 inches thick. The subsurface layer is black, firm silty clay loam about 27 inches thick. The substratum to a depth of 72 inches is very dark gray, dark gray, and gray, mottled, firm silty clay loam. In some places, the surface soil is silt loam, and in some small areas it is silty clay below a depth of 15 inches. In some areas, the soil is nearly level.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is high, and the content of organic matter is very high. The surface layer is friable and is easily tilled within a moderate range of moisture content. The shrink-swell potential is high. A high water table, at a depth of 1 to 3 feet, is common during extended wet periods.

In most areas this soil is used for row crops, hay, and pasture. In a few narrow areas it is used as woodland. This soil is suited to corn, soybeans, small grains, and grasses and legumes. Stream channels make some areas inaccessible to farm equipment. Ditchbank erosion and runoff from uplands are hazards. Careful maintenance of permanent vegetation along stream channels helps stabilize ditchbanks. Diversions protect the soil from excess runoff from the adjacent uplands. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

A pasture and hay mixture that includes wetness-tolerant varieties grows well on this soil. Overgrazing a pasture reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition. In low areas, small drainage ditches or land grading helps prevent damage to perennial plants caused by frost action.

This soil generally is not suitable for building site development because of occasional flooding.

This soil is in capability subclass IIw.

61—Nodaway silt loam. This is a deep, nearly level, moderately well drained soil on flood plains of medium and large drainageways. It is subject to occasional flooding. Individual areas are one-half mile to several miles in length, vary in width, and range from 20 to several hundred acres or more in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 8 inches thick. The substratum to a depth of 65 inches is very friable silt loam. The upper part is very dark grayish brown and has many splotches and very thin strata of dark grayish brown. The middle part is very dark grayish brown and has many thin strata of dark grayish brown. The lower part is stratified very dark gray, dark grayish brown, and grayish brown. In several small areas, the underlying material is not stratified. In some areas, it is black silty clay loam.

Included with this soil in mapping are a few areas where the soil is more than 15 percent sand throughout.

Permeability is moderate, and surface runoff is slow. The available water capacity is very high. Reaction in the surface layer varies widely because of local liming practices. Natural fertility is high, and the content of organic matter is moderate. The surface layer is friable and is easily tilled within a wide range of moisture content. The shrink-swell potential is moderate. A seasonal high water table, at a depth of 3 to 5 feet, is common during extended wet periods.

In most areas this soil is used for row crops. In many small, narrow areas it is used as woodland and pasture. This soil is well suited to corn, soybeans, small grains, and grasses and legumes. It has no significant limitations for agricultural production if it is protected from flooding. In some uneven areas, land grading makes the soil easier to farm. Returning crop residue or regularly adding other organic material helps improve fertility, reduce crusting, and increase water infiltration.

Deep-rooted legumes, alfalfa, for example, grow well on this soil if flooding is very brief. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing of weedy pasture reduces competition by undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is suited to trees. In several small areas it is in walnut and native hardwoods. Plant competition is a management concern. When trees are planted, careful site preparation, including spraying or cutting, is

necessary in some areas. There are no other hazards or limitations in planting or harvesting trees.

This soil generally is not suitable for building site development because of occasional flooding.

This soil is in capability subclass IIw.

99—Pits, quarry. This map unit consists of open excavations from which soil material has been removed to mine the underlying limestone.

Typically, a quarry has a vertical face or exposure on two or three sides. These exposures range from 6 to more than 40 feet high and are made up mostly of limestone and lesser amounts of shale. Above this vertical rock face are thin layers of glacial material 1 to 10 feet thick. In some areas 3 to 10 feet of loess overlies the glacial material. The overburden is removed and stockpiled on adjoining undisturbed areas or put in previously mined pits.

Some recently mined areas have been reshaped and reseeded. The topsoil in these areas is a mixture of subsoil and gravelly material and has very poor tilth and very little organic matter. In these areas the soil can be used for pasture. However, it is best suited to use for wildlife and recreational development. The unreclaimed areas are rough and steep and are covered mainly by weeds and brush. In some areas drainage outlets are not available, and the pits are filled with water. Most quarries can be reclaimed and made suitable for use as wildlife habitat or for recreational uses. Some fringe areas can be used for dwellings.

This map unit was not assigned to a capability subclass.

prime farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Clinton County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Figure 10.—The soils making up the Sharpsburg-Higginsville-Lamoni association are used mainly for cultivated crops, hay, and pasture.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be used as cropland, pasture, or woodland, or they may be in other uses. They are used either for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

Soils that have a high water table may qualify as prime farmland soils if this limitation is overcome by drainage. Onsite evaluation is necessary to determine the effectiveness of corrective measures. In this survey area many of the naturally wet soils have been adequately drained by drainage systems or as a result of normal farm operations or other kinds of land development. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 103,000 acres, or nearly 38 percent of Clinton County, is prime farmland. Most of the prime farmland is in the northern, western, and central parts of the county. Other areas are scattered throughout the rest of the county. The largest areas are in soil associations 1, 2, and 5 on the general soil map (fig. 10). In 1967, approximately 31,000 acres of prime farmland was used for crops, mainly corn, soybeans, and grain sorghum.

A recent trend in land use in some parts of the county has been the conversion of small acreages of prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in Clinton County. On some soils included in the list, corrective measures to overcome wetness have been applied. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed soil map units." This list does not constitute a recommendation for a particular land use.

1B	Marshall silt loam, 2 to 5 percent slopes
7B	Sharpsburg silty clay loam, 2 to 5 percent slopes
13	Haig silt loam (where drained)
14B	Grundy silt loam, 2 to 5 percent slopes
14B2	Grundy silty clay loam, 2 to 5 percent slopes, eroded
16B	Ladoga silt loam, 2 to 5 percent slopes
22	Wiota silt loam
23	Bremer silty clay loam (where drained)
24	Nevin silt loam
52	Kennebec silt loam
55B	Colo silty clay loam, 2 to 5 percent slopes (where drained)
61	Nodaway silt loam

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

Martin W. Burch, district conservationist, Soil Conservation Service, assisted in the writing of this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 223,000 acres in the survey area, or 83 percent of the county, were used for crops and pasture in 1967 (*7*). Of this total, about 107,000 acres were used for permanent pasture; 74,000 acres for cultivated crops, mainly corn, soybeans, sorghum, and wheat; and 15,000 acres for rotation hay and pasture. The remaining 27,000 acres were used mainly for conservation purposes or were idle cropland. In 1979, about 86,800 acres were used for cultivated crops (*6*). Loss of cropland to highway construction and urban development has been slight.

Because of livestock market fluctuations in the 1970's, the acreage used for row crops has increased, and the acreage in permanent pasture has shown a corresponding decrease.

The potential of the soils in Clinton County for sustained production of food is good. About 38 percent, or 103,000 acres, of the county is prime farmland. However, only about 20 percent of the cropland and pastureland is being adequately treated to meet conservation needs (*7*). Most of the cropland not adequately treated is in upland areas and is being farmed in a manner that causes erosion in excess of what is considered tolerable to sustain production over a long period of time. Some of the marginal cropland used for row crops should be converted to pasture and hayland. Soil erosion on most of the cropland can be held to a tolerable amount by using a system of conservation practices designed for specific sites.

Soil erosion is the major problem on nearly all sloping cropland and overgrazed pastureland in Clinton County. All soils that have slopes of more than 2 percent are susceptible to damage from erosion. Haig and Bremer soils have limitations for some agricultural uses because of wetness.

Loss of the surface layer through erosion results in reduced productivity. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, which is incorporated into the plow layer. Armstrong,

Clarinda, Grundy, and Lamoni soils have a clayey subsoil. In many fields, seedbed preparation and tillage are difficult on clayey spots where the original friable surface soil has been eroded away. Erosion also reduces the productivity of soils that tend to be droughty and are shallow to bedrock, such as Gasconade and Vanmeter soils.

Soil erosion on farmland results in sediment entering streams, lakes, and ponds. Controlling erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and wildlife. It prolongs the useful life of ponds and lakes by preventing them from filling up with sediment.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps vegetative cover or residue on the soil can hold erosion losses to amounts that will not reduce the productive capacity of the soils. Growing grasses and legumes for pasture and hay is very effective in controlling erosion. Legumes, clover and alfalfa, for example, used in the crop rotation improve tilth and provide nitrogen for the following crop.

Terraces reduce the length of slopes and reduce runoff and erosion. Conventional terraces are most practical on uneroded upland soils that have long smooth slopes of less than 8 percent. Special construction and management techniques are necessary for terrace systems to be effective in most areas of strongly sloping Armstrong, Gara, Lamoni, and Shelby soils. Soil loss on moderately steep Gara soils is severe if these soils are cultivated for row crops. Grassed backslope terraces reduce the steepness of the slope, whereas conventional terraces increase the slope, making additional erosion control practices crucial. On strongly sloping soils, a cropping system that provides substantial vegetative cover is needed to control erosion, unless conservation tillage is practiced and a large amount of residue is utilized. Minimizing tillage on sloping soils and leaving a large quantity of crop residue on the surface help increase infiltration and reduce the hazard of runoff and erosion. These practices can be adapted to many of the soils in the survey area but are more difficult to use successfully on eroded soils that have a clayey surface layer. In some areas of Armstrong, Clarinda, Grundy, and Lamoni soils, special management is required if terracing has exposed the clayey subsoil.

If the soil is not suited to terraces or an individual farmer prefers not to construct terraces, other conservation practices effectively control erosion. Contour stripcropping reduces erosion through the use of contoured strips of permanent vegetation. These grass or grass-legume strips are generally used for hay, and the areas between the strips are cultivated. Row crops are planted on the contour. No-till planting is becoming more common and is effective in reducing erosion on sloping soils. It can be used on many of the soils in the survey area, although severely eroded soils require special management.

Soil drainage and flood control are management concerns on about 13 percent of the acreage used for crops and pasture. Bremer and Haig soils are naturally so wet that crop production is reduced during some part of the year. Land grading or surface drainage are needed to some extent on these soils. Occasional flooding can be a problem on the Colo, Kennebec, and Nodaway soils. If flooding occurs, it is commonly during the period from November through June.

Soil fertility is naturally lower for most of the eroded soils and shallow soils in the survey area. However, all of the soils require additional plant nutrients for maximum production. Most of the soils are naturally acid in the upper part of the rooting zone and require applications of ground limestone to raise the pH and calcium level sufficiently for optimum growth of legumes. On all of the soils, additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the production level desired. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and infiltration of water into the soil. Soils with good tilth are granular and porous. The tilth of each soil is given in the section "Detailed soil map units."

Most of the uneroded upland soils that are used for crops have a silt loam or silty clay loam surface layer that is dark in color and medium to high in content of organic matter. Generally, the structure of the silt loam soils becomes weaker from tillage and compaction, and intense rainfall causes the formation of a crust on the surface. The crust is hard when dry. It reduces water infiltration and increases runoff. Regularly adding crop residue, manure, and other organic material helps improve soil structure and tilth.

All of the eroded upland soils have more clay in the surface layer and have poorer tilth, slower infiltration, and more rapid runoff than corresponding uneroded soils. Eroded soils need conservation practices that can prevent further erosion.

Fall plowing is common in the survey area. However, most of the upland soils that are used as cropland are sloping and are subject to damaging erosion if they are plowed in the fall.

Bremer and Haig soils are clayey and in many years stay wet until late in spring. If they are wet when plowed, they tend to be cloddy when dry, and a seedbed is difficult to prepare. Fall plowing generally results in better tilth and does not result in damaging erosion because the soils are nearly level.

Corn and soybeans are the field crops best suited to the soils and climate of the survey area and are the most commonly grown. In 1976, they were grown on about 66,000 acres. Grain sorghum was grown on about 6,000 acres.

Wheat is the most common close-growing crop. It was grown on about 7,500 acres in 1976. Oats and rye can be grown, and grass seed can be produced from bromegrass, fescue, and orchardgrass.

Pasture and hay crops suited to the soils and climate of Clinton County include several legumes, cool season grasses, and warm season native grasses. Alfalfa and red clover are the common legumes grown for hay. They are also grown with bromegrass, orchardgrass, or timothy for hay and pasture.

Warm season native grasses adapted to the survey area are big bluestem, little bluestem, indiangrass, and switchgrass. These grasses produce well during the hot summer months. They need different management techniques for establishment and grazing than cool season grasses.

Deep, moderately well drained or well drained soils, for example, Clinton, Gara, Kennebec, Ladoga, Marshall, Nodaway, Sharpsburg, Shelby, and Wiota soils, are the best for alfalfa. The other legumes and all grasses do well on most of the upland soils. Wetness-tolerant species should be selected for planting on Bremer, Colo, and Haig soils.

The major management concerns on most of the pastureland are overgrazing and gully erosion. Grazing should be controlled so that plants survive and achieve maximum production. Keeping grasses at a desirable height reduces runoff and gully erosion.

Two types of irrigation are currently used in Clinton County, the center pivot and the rain-gun systems (fig. 11). These systems increase yields by supplying supplemental water during critical periods of crop growth.

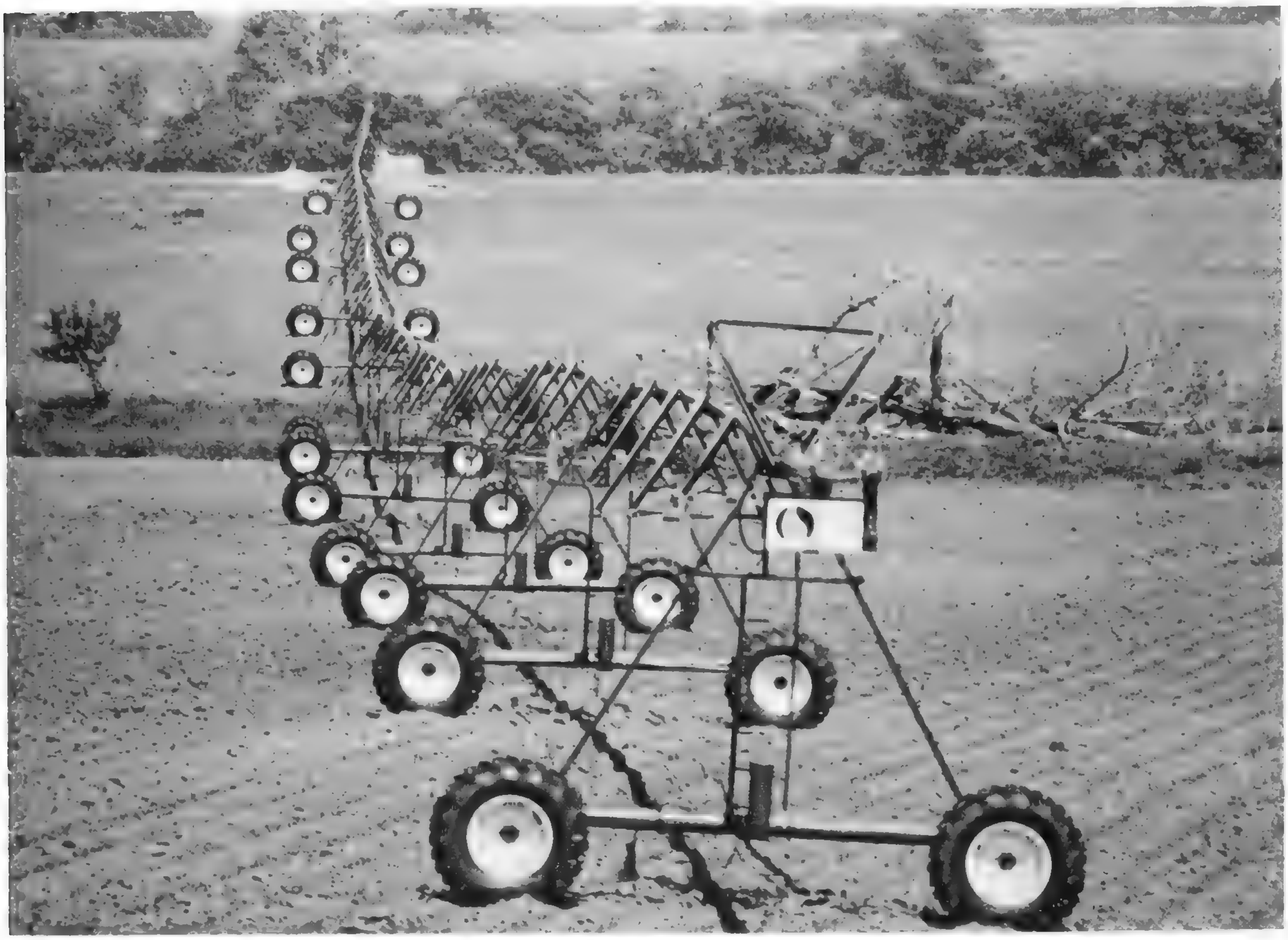


Figure 11.—This center-pivot irrigation system on Grundy silt loam, 5 to 9 percent slopes, can increase crop production. However, special management is needed to control erosion.

Irrigation also makes double-cropping a feasible alternative in cropping systems. Soybeans can be planted directly into wheat stubble, because the irrigation system supplies enough water to insure germination and crop growth. The large amount of residue on the surface helps protect the soil from erosion.

In considering the costs and benefits of an irrigation system, soil and water conservation practices must be included. Immediately after irrigation, the saturated topsoil is extremely vulnerable to erosion if intense rainfall occurs. Accelerated erosion can drastically reduce natural fertility and cause rapid sedimentation in bodies of water downstream. There are no wells in Clinton County that can produce enough water for irrigation. Protecting the topsoil from erosion helps prevent the sedimentation of reservoirs that supply water for irrigation.

Careful maintenance of terraces is another management concern. If ruts are allowed to develop where the wheels of the irrigation equipment pass over the saturated berm of the terrace, the effectiveness of the terrace is reduced.

Small acreages of specialty crops, tobacco, sunflowers, and Christmas trees, for example, are grown in Clinton County. These crops require special equipment, management, and propagation techniques.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*14*). Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

There are no class V or class VIII soils in Clinton County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w,* or *s* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); and *s* shows that the soil is limited

mainly because it is shallow, droughty, or stony. In class I there are no subclasses because the soils of this class have few limitations.

The capability classification of each map unit is given in the section "Detailed soil map units."

woodland management and productivity

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

According to a 1972 Forest Service inventory, Clinton County has 18,500 acres of woodland. The acreage in woodland has declined approximately 18 percent since 1959, when 22,500 acres were in woodland.

Clinton County's woodland is mainly in the Armstrong-Gara-Ladoga association. The forest is predominantly white oak, northern red oak, and hickory. White ash, sugar maple, American elm, winged elm, basswood, hackberry, and black walnut are commonly associated with this forest.

Some of the minor soils in this association, Vanmeter, Gasconade, Kennebec, and Nodaway soils, in places are used as woodland.

The Vanmeter and Gasconade soils generally have more hickory, hackberry, sugar maple, elm, and post oak than the major soils. The forest on these soils is characterized by slow growth, and the production potential is low.

The Kennebec and Nodaway soils, where timbered, in many areas are in desirable bottom land hardwoods, especially black walnut. The production potential is high for these species.

The small bottom lands in the Armstrong-Gara-Ladoga association, and much of the prairie land in the other associations, are characterized by the elm-ash-cottonwood forest type. Box elder, silver maple, American elm, cottonwood, and green ash are generally the most common species. Other species present in the forest stands are sycamore, pecan, hickories, sugarberry or hackberry, pin oak, river birch, and other moist-site hardwoods.

Table 6 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, keep snow from blowing off the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service, the Missouri Department of Conservation, or the Cooperative Extension Service or from a commercial nursery.

recreation

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) shows a total of 2,038 acres of existing recreational developments in Clinton County (*12*). The facilities listed include playfields, fishing and boating water, hiking trails, and areas for swimming, camping, and picnicking. A 1976 report projected the minimum increase in miles of foot trails and bike paths and in areas for fishing and hunting to meet the needs caused by the projected growth in the total county population (*3*).

None of the county or municipal parks is larger than 100 acres in size. Wallace State Park is 421 acres in size and is located in the northeastern section of the county. It features a 7-acre lake and can be used for camping, picnicking, hiking, swimming, and fishing. The park is well used in summer.

Smithville Lake provides water-based recreation to 1,400,000 annual visitors and 11,500 people a day each weekend of the summer. Nearly 6,000 acres are devoted to recreational development. The structure is located on the Little Platte River 5 miles north of Kansas City, near Smithville. The 7,190-acre lake has 175 miles of shoreline. When filled to flood capacity, the lake covers 10,000 acres and extends 18 miles up the valley to Plattsburg.

Six public parks connected with the reservoir are planned. Two of these, Honker Cove and Plattsburg Park, are in Clinton County. Honker Cove will feature interpretative nature programs as well as picnic facilities for day use. The second park will feature picnic facilities and ballfields. Hunting will be allowed on all public lands unless posted for security and safety purposes. The Smithville Lake project should fulfill nearly all of the projected recreation facility needs identified in the 1970 SCORP for Clinton County.

The 1974 NACD Nationwide Outdoor Recreation Inventory listed several private and semiprivate commercial recreation enterprises, including swimming clubs, golf courses, riding stables, lake development properties, a sportsman's organization, and a racquetball club (*5*). Each county committee responsible for preparing the inventory was asked to list the two top priority recreation needs in the county. In Clinton County the first priority was determined to be new areas for field sports and the second priority, additional fishing lakes. The Smithville Lake project will supply both these needs as well as many other recreational opportunities for residents and visitors.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table

11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

Clinton County is 1 of 12 counties that make up the Northwest Prairie Zoogeographic Region in Missouri. Prior to cultivation, 65 percent of this region was prairie, and 35 percent was woodland (*8*). Today, only a trace of the original prairie remains. Now, approximately 43 percent of Clinton County is classified as cultivated cropland, 33 percent as grassland, and 19 percent as woodland, including areas of shrub and brush growth. The remainder is classified as other land, including urban areas, transportation corridors, and water (*4*).

The Vanmeter and Gasconade soils, minor soils in the Armstrong-Gara-Lodoga association, are dominantly covered by wooded vegetation. About 35 percent of the Armstrong-Gara-Ladoga association is in woody vegetation. This association provides over half of the total forested habitat in Clinton County. The other associations contain nearly 30,000 acres of woodland.

The county's deer population is presently rated as fair. Predictions indicate that it will increase to a good rating. Turkeys are very scarce. Occasionally one or two are sighted in the vicinity of Wallace State Park. Two border counties have received turkey releases, and if the project is successful, offspring from these birds can be moved into suitable habitat in Clinton County. The squirrel population is rated as excellent and consists mainly of fox squirrel. Woodcock are observed only during the fall migration period.

The furbearer population is rated as fair. The Smithville reservoir is expected to create additional habitat in the southern part of the county for these animals. Harvest records show that raccoon, coyote, muskrat, opossum, red fox, and beaver are the principal species trapped.

Approximately 75 percent of the county is classified as cropland and grassland. The Grundy, Sharpsburg-Higginsville-Lamoni, Lamoni, and Marshall-Higginsville soil associations provide most of the openland habitat for wildlife in Clinton County. There are many waterways, hedgerows, and other areas of woody or brushy cover throughout these associations. These hard-cover areas supply a type of habitat that is rapidly disappearing in many parts of northern Missouri.

The bobwhite quail is the most popular game species in the county, and the population is rated as good. Rabbit numbers are reported to be good. The abundant supply of food in close proximity to good woody cover creates a habitat favorable for quail and rabbits throughout much of the county. The resident dove population is fair and increases each year as a result of migratory flights.

Occasionally a pheasant sighting is confirmed, although the population of this game bird is considered to be very low. Very little original prairie remains in Clinton County, and the typical species of prairie wildlife are very rare. For the past several years, there have been no confirmed sightings of prairie chicken and only a few reports of jackrabbit.

There are no major wetland areas in any of the soil associations in Clinton County, and the waterfowl population is rated as poor. There are small populations of wood duck on timbered streams, where the habitat meets the strict requirements. Many of the lakes and ponds in the county are used as resting sites by migrating waterfowl. Periodically, waterfowl from the Squaw Creek National Wildlife Refuge in Holt County visit crop fields to feed. When completed, the Smithville Lake project will create habitat for many wetland species.

Streams, lakes, and farm ponds provide opportunities for fishing. No permanent streams are listed for Clinton County. There are, however, many intermittent streams that are suitable for fishing. The most important are the Little Platte River (Smith's Fork) and Castile, Shoal, and Grindstone Creeks. These waters contain channel catfish, black and yellow bullheads, largemouth bass, crappie, carp, buffalo, green sunfish, and bluegill. McGuire Branch, Roberts Branch, and Horse Fork offer several miles of pools that have a bullhead and sunfish fishery. According to the latest estimate, there are more than 3,000 farm ponds and small private lakes in the county that have been stocked with fish. Species include largemouth bass, channel catfish, and bluegill.

The 7-acre lake at Wallace State Park and the city reservoirs at Gower, Plattsburg, and Cameron provide the only impoundment fishing in the county. These lakes offer opportunities to fish for bass, bluegill, channel catfish, and crappie. Smithville Lake will create over 7,000 acres of water, increasing opportunities for fishing and adding northern pike to the county's fishery.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, millet, soybeans, and milo.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bluegrass, switchgrass, orchardgrass, indiangrass, bromegrass, clover, alfalfa, trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, pokeweed, foxtail, croton, and partridge pea.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, wild plum, blackberry, sumac, persimmon, and sassafras. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, crabapple, Amur honeysuckle, and hazelnut.

Coniferous plants furnish winter cover, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cutgrass, cattail, rushes, sedges, and buttonbush.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow

water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite, pheasant, meadowlark, field sparrow, cottontail, red fox, woodchuck, and mourning dove.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, muskrat, mink, and beaver.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses (fig. 12); (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer;

Figure 12.—The soils in the Armstrong-Gara-Ladoga association are suitable for housing developments and for recreation purposes.

stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, and shrink-swell potential can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive

or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across

a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil is as much as 15 to 20 percent particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops.

They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. Only saturated zones within a depth of about 6 feet are indicated.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*15*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudoll (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*13*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*15*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Armstrong series

The Armstrong series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in weathered glacial till. Slopes range from 5 to 14 percent.

Armstrong soils are similar to Gara soils and commonly are adjacent to Clinton, Gara, Gasconade, Ladoga, and Vanmeter soils. Unlike Armstrong soils, Clinton and Ladoga soils have a silt loam surface layer and do not have glacial sand and pebbles. They are on side slopes and ridgetops at a higher elevation than

Armstrong soils. Gara soils do not have red mottles or mottles of chroma of 2 in the upper part of the B horizon. Gasconade and Vanmeter soils are strongly sloping to very steep. They are in lower positions on the landscape. Gasconade soils are shallow and are somewhat excessively drained. Vanmeter soils are moderately deep and are moderately well drained.

Typical pedon of Armstrong loam, 5 to 9 percent slopes, in a bluegrass pasture, 1,120 feet east and 1,915 feet north of the southwest corner of sec. 27, T. 55 N., R. 33 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

B1t—8 to 11 inches; brown (7.5YR 4/2) clay loam; few fine prominent yellowish red (5YR 4/6) mottles; weak very fine subangular blocky structure; firm; medium acid; clear smooth boundary.

B21t—11 to 15 inches; brown (7.5YR 5/4) clay loam; few fine prominent yellowish red (5YR 4/6) mottles; moderate very fine and fine subangular blocky structure; firm; few thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

IIB22t—15 to 22 inches; brown (7.5YR 5/4) clay; many fine prominent red (2.5YR 4/6) and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; very firm; common thin discontinuous clay films on faces of peds; few fine pebbles; medium acid; gradual smooth boundary.

IIB23t—22 to 29 inches; brown (7.5YR 5/4) clay; common medium prominent yellowish red (5YR 5/6) and few fine prominent gray (10YR 6/1) mottles; moderate fine prismatic structure; firm; common thin patchy clay films on faces of peds; few fine pebbles; medium acid; gradual smooth boundary.

IIB24t—29 to 41 inches; brown (7.5YR 5/4) clay; many medium prominent gray (10YR 6/1), many medium distinct strong brown (7.5YR 5/6), and few medium distinct yellowish red (5YR 4/6) mottles; weak fine prismatic structure; firm; few thin patchy clay films on faces of peds; few black stains; few fine pebbles; slightly acid; gradual smooth boundary.

IIB3—41 to 72 inches; mottled strong brown (7.5YR 5/6) and gray (10YR 6/1) clay loam; weak fine prismatic structure; firm; few black stains; few fine black concretions (oxides); few fine pebbles; neutral.

The solum is 42 to more than 72 inches thick.

The A horizon is dominantly loam, although the range includes clay loam. The B2 horizon has hue of 10YR through 5YR, value of 4 or 5, and chroma of 3 through 6.

Armstrong clay loam, 5 to 9 percent slopes, severely eroded, and Armstrong clay loam, 9 to 14 percent slopes, severely eroded, do not have the dark surface layer that is definitive for the series. However, this difference does not significantly affect the use and management of the soils.

Bremer series

The Bremer series consists of deep, poorly drained, moderately slowly permeable soils on low stream benches or second bottoms. These soils formed in silty alluvium. Slope is generally less than 2 percent.

Bremer soils are similar to Haig soils and commonly are adjacent to Kennebec, Nevin, Nodaway, and Wiota soils. Haig soils have a thinner mollic epipedon and more clay in the B2 horizon than Bremer soils. Kennebec and Nodaway soils are moderately well drained. They have less clay and are on the lower part of the flood plain adjacent to the stream channel. Nevin soils are somewhat poorly drained. They have less clay and are in slightly higher positions on the perimeter of areas of Bremer soils. Wiota soils are moderately well drained. They have less clay and are in slightly higher positions similar to those of the Bremer soils.

Typical pedon of Bremer silty clay loam, 925 feet west and 530 feet south of the center of sec. 19, T. 56 N., R. 32 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—9 to 17 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

B21t—17 to 25 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine prismatic structure; firm; few thin discontinuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B22tg—25 to 33 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine prominent dark yellowish brown (10YR 4/4) mottles; weak fine prismatic structure; firm; few thin discontinuous clay films on faces of peds; slightly acid; clear smooth boundary.

B23tg—33 to 42 inches; dark gray (10YR 4/1) silty clay loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak fine prismatic structure; firm; few thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

B3g—42 to 56 inches; gray (5Y 5/1) silty clay loam; common fine prominent yellowish brown (10YR 5/8) mottles; weak fine prismatic structure; firm; few fine black concretions (oxides); slightly acid; gradual smooth boundary.

Cg—56 to 66 inches; gray (5Y 5/1) silty clay loam; common fine and medium prominent yellowish brown (10YR 5/8) mottles; massive; firm; few black stains; common fine black concretions (oxides); neutral.

The solum is 40 to 56 inches thick. The mollic epipedon is 30 to 36 inches thick.

The A horizon is 14 to 21 inches thick. It is dominantly silty clay loam, although the range includes silt loam. The lower part of the B horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 1 or 2.

Clarinda series

The Clarinda series consists of deep, poorly drained, very slowly permeable soils on uplands. These soils formed in gray clayey paleosols. Slopes range from 5 to 9 percent.

These soils in Clinton County have a dark surface layer that is thinner than is definitive for the Clarinda series. However, this difference does not significantly affect the use and management of the soils.

Clarinda soils commonly are adjacent to Grundy and Lamoni soils. Grundy soils are not as gray and have less clay in the B horizon. They are on side slopes and ridgetops upslope from Clarinda soils. Lamoni soils have less clay and have more sand and pebbles in the B horizon. They are commonly downslope from Clarinda soils.

Typical pedon of Clarinda silty clay loam, 5 to 9 percent slopes, eroded, 265 feet east and 100 feet north of the center of sec. 26, T. 57 N., R. 33 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; friable; strongly acid; clear smooth boundary.

A3—6 to 9 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; firm; medium acid; clear smooth boundary.

IIB21tg—9 to 13 inches; dark gray (10YR 4/1) clay; few fine prominent dark brown (7.5YR 4/4) mottles; moderate very fine and fine subangular blocky structure; firm; common thick discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

IIB22tg—13 to 17 inches; gray (5Y 5/1) clay; common fine prominent brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; very firm; common thick continuous clay films on faces of peds; medium acid; clear smooth boundary.

IIB23tg—17 to 26 inches; gray (5Y 5/1) clay; moderate fine prismatic structure; very firm; few fine white sand grains; common thin discontinuous clay films on faces of peds; neutral; gradual smooth boundary.

IIB24tg—26 to 38 inches; gray (5Y 6/1) clay; common fine distinct olive (5Y 5/4) and light olive brown (2.5Y 5/6) mottles; weak fine prismatic structure; firm; many fine white sand grains; mildly alkaline; gradual smooth boundary.

IIB3g—38 to 64 inches; gray (5Y 6/1) clay; common medium prominent yellowish brown (10YR 5/8) and common fine distinct olive (5Y 5/4) mottles; weak coarse prismatic structure; firm; many fine white sand grains; mildly alkaline.

The Ap horizon is dominantly silty clay loam, but in some pedons it is silt loam. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The dark surface layer is 6 to 9 inches thick. The IIB horizon is commonly clay. In some pedons, however, the upper part is silty clay. The IIB horizon has hue of 10YR through 5Y and value of 4 through 6. Chroma is dominantly 1, although in some subhorizons it is 2.

Clinton series

The Clinton series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in loess. Slopes range from 5 to 9 percent.

Clinton soils are similar to Ladoga soils and commonly are adjacent to Armstrong, Gara, and Ladoga soils. Armstrong and Gara soils have glacial sand and pebbles throughout and are downslope from Clinton soils. Ladoga soils have a dark colored surface layer more than 6 inches thick.

Typical pedon of Clinton silt loam, 5 to 9 percent slopes, eroded, 925 feet west and 260 feet north of the southeast corner of sec. 8, T. 54 N., R. 32 W.

Ap—0 to 6 inches; dark brown (10YR 4/3) silt loam; weak very thin platy and very fine granular structure; very friable; slightly acid; clear smooth boundary.

B1—6 to 9 inches; dark brown (10YR 4/3) silty clay loam; weak very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21t—9 to 14 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate very fine subangular blocky structure; firm; few thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—14 to 20 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate very fine and fine subangular blocky structure; firm; common thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B23t—20 to 30 inches; yellowish brown (10YR 5/4) silty clay loam; few fine distinct light brownish gray (10YR 6/2) mottles; moderate fine subangular blocky structure; firm; few thin clay films on faces of peds; medium acid; gradual smooth boundary.

B24t—30 to 38 inches; yellowish brown (10YR 5/4) silty clay loam; common fine distinct light brownish gray (10YR 6/2) mottles; moderate fine subangular blocky structure; firm; few thin clay films on faces of peds; strongly acid; gradual smooth boundary.
B3—38 to 43 inches; yellowish brown (10YR 5/4) silty clay loam; few fine prominent strong brown (7.5YR 5/8) and common fine distinct light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; firm; strongly acid; gradual smooth boundary.
C—43 to 74 inches; light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) silty clay loam; massive; firm; medium acid.

The solum is 43 to 60 inches thick. It is medium acid to strongly acid in the most acid part.

The Ap horizon dominantly has hue of 10YR, value of 4, and chroma of 3. Some pedons have an A1 horizon that has hue of 10YR, value of 3 or 4, and chroma of 2. The B2 horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4.

Colo series

The Colo series consists of deep, poorly drained, moderately permeable soils on narrow upland drainageways. These soils formed in silty sediment. Slopes range from 2 to 5 percent.

Colo soils commonly are adjacent to Grundy, Higginsville, Lamoni, Marshall, Sharpsburg, and Shelby soils. All of these soils formed in loess or glacial till on uplands and are in higher positions than Colo soils.

Typical pedon of Colo silty clay loam, 2 to 5 percent slopes, 55 feet west and 1,060 feet north of the center of sec. 15, T. 56 N., R. 33 W.

A11—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary.
A12—10 to 25 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate very fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.
A13—25 to 37 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine prismatic structure parting to weak fine angular blocky; firm; neutral; diffuse smooth boundary.
AC—37 to 54 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak fine angular blocky; firm; neutral; gradual smooth boundary.
C1g—54 to 65 inches; dark gray (10YR 4/1) silty clay loam; common fine prominent yellowish brown (10YR 5/8) mottles; massive; firm; neutral; gradual smooth boundary.
C2g—65 to 72 inches; gray (5Y 5/1) silty clay loam; common medium prominent yellowish brown (10YR 5/8) mottles; massive; firm; neutral.

The solum is slightly acid to neutral.

The Ap horizon is dominantly silty clay loam, although the range includes silt loam. The A horizon has hue of N, value of 2, and chroma of 0 or has hue of 10YR, value of 2 or 3, and chroma of 1.

Gara series

The Gara series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 9 to 20 percent.

Gara soils are similar to Ladoga and Shelby soils and commonly are adjacent to Armstrong, Gasconade, Kennebec, Ladoga, and Vanmeter soils. Armstrong soils are somewhat poorly drained. They have red mottles and mottles of chroma of 2 in the upper part of the B horizon. They are in higher positions than Gara soils or in similar positions. Gasconade soils are shallow and somewhat excessively drained. Vanmeter soils are moderately deep. Gasconade and Vanmeter soils are in lower positions than Gara soils. They do not have glacial sand or pebbles. Kennebec soils are silt loam throughout and are on small flood plains. Ladoga soils do not have glacial sand and pebbles. Shelby soils have a mollic epipedon.

Typical pedon of Gara loam, 9 to 14 percent slopes, 125 feet west and 460 feet south of the center of sec. 30, T. 56 N., R. 32 W.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; strongly acid; clear smooth boundary.
A2—7 to 10 inches; dark grayish brown (10YR 4/2) loam; weak fine granular structure; very friable; strongly acid; clear smooth boundary.
B21t—10 to 15 inches; yellowish brown (10YR 5/4) clay loam; moderate very fine subangular blocky structure; firm; few thin patchy clay films on faces of peds; very strongly acid; gradual smooth boundary.
B22t—15 to 23 inches; yellowish brown (10YR 5/4) clay loam; moderate very fine subangular blocky structure; firm; common thin discontinuous clay films on faces of peds; extremely acid; gradual smooth boundary.

B23t—23 to 36 inches; yellowish brown (10YR 5/4) clay loam; common fine prominent light brownish gray (10YR 6/2) mottles; moderate fine prismatic structure; firm; few thin patchy clay films on faces of peds; extremely acid; clear smooth boundary.

B3—36 to 51 inches; yellowish brown (10YR 5/6) clay loam; common fine and medium prominent light brownish gray (2.5Y 6/2) and common medium prominent strong brown (7.5YR 5/8) mottles; weak fine prismatic structure; firm; few black stains on faces of peds; strongly acid; clear smooth boundary.

C—51 to 60 inches; yellowish brown (10YR 5/6) clay loam; common fine prominent light brownish gray (2.5Y 6/2) mottles; massive; firm; strong effervescence; moderately alkaline.

The solum is 36 to 54 inches thick. It is strongly acid to extremely acid.

The Ap or A1 horizon is 6 to 9 inches thick. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 through 6.

Gasconade series

The Gasconade series consists of shallow, somewhat excessively drained, moderately slowly permeable soils on uplands. These soils formed in material that weathered from interbedded limestone and shale. Slopes range from 14 to 50 percent.

Gasconade soils commonly are adjacent to Bremer, Gara, Nodaway, and Vanmeter soils. Bremer soils are deep and poorly drained and are on terraces at a lower elevation. Gara soils are deep, have glacial sand and pebbles, and are upslope from Gasconade soils. Nodaway soils are deep and moderately well drained. They are on flood plains at a lower elevation. Vanmeter soils are moderately deep and are typically downslope in positions similar to those of Gasconade soils.

Typical pedon of Gasconade flaggy silty clay loam, in an area of Vanmeter-Gasconade complex, 14 to 50 percent slopes, 345 feet east and 90 feet south of the center of sec. 35, T. 55 N., R. 32 W.

A1—0 to 4 inches; black (10YR 2/1) flaggy silty clay loam, dark gray (10YR 4/1) dry; strong fine and medium angular blocky structure; very firm; approximately 10 percent limestone fragments less than 3 inches wide, 15 percent fragments 1 to 3 inches thick and 3 to 8 inches wide, and 5 percent fragments more than 8 inches wide; mildly alkaline; clear smooth boundary.

B1—4 to 8 inches; very dark grayish brown (10YR 3/2) flaggy silty clay; moderate fine subangular blocky structure; firm; fragments approximately the same as those in the A1 horizon; mildly alkaline; clear smooth boundary.

B2—8 to 11 inches; dark brown (10YR 3/3) flaggy silty clay; weak and moderate very fine subangular blocky structure; firm; approximately 10 percent limestone fragments less than 3 inches wide, 30 to 60 percent fragments 1 to 3 inches thick and 3 to 8 inches wide, and 10 percent fragments more than 8 inches wide; slight effervescence; mildly alkaline; clear smooth boundary.

B3—11 to 18 inches; dark brown (10YR 4/3) flaggy silty clay; weak very fine subangular blocky structure; firm; fragments approximately the same as those in the B2 horizon; slight effervescence; mildly alkaline.

R—18 inches; limestone bedrock.

The solum is 9 to 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 through 4. It is flaggy silty clay loam or flaggy silty clay.

Grundy series

The Grundy series consists of deep, somewhat poorly drained, slowly permeable soils on wide upland ridgetops. These soils formed in noncalcareous loess. Slopes range from 2 to 9 percent.

Grundy soils are similar to Lamoni soils and commonly are adjacent to Haig and Lamoni soils. Haig soils are poorly drained and are on nearly level, wide ridgetops. Lamoni soils have more sand and pebbles throughout and are moderately sloping. They are in lower positions than Grundy soils.

Typical pedon of Grundy silt loam, 2 to 5 percent slopes, 1,450 feet west and 135 feet south of the northeast corner of sec. 26, T. 57 N., R. 31 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

A12—9 to 12 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular and weak very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—12 to 16 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; firm; few fine black concretions (oxides); medium acid; gradual smooth boundary.

B21t—16 to 22 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) and few fine prominent yellowish red (5YR 5/6) mottles; moderate fine subangular blocky structure; firm; many very dark gray thick continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—22 to 29 inches; grayish brown (10YR 5/2) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; common dark gray moderately thick continuous clay films on faces of peds; few fine black concretions (oxides); slightly acid; gradual smooth boundary.

B23t—29 to 36 inches; grayish brown (2.5Y 5/2) silty clay; common fine prominent dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; common moderately thick continuous clay films on faces of peds; common fine black concretions (oxides); neutral; gradual smooth boundary.

B3t—36 to 47 inches; olive gray (5Y 5/2) silty clay loam; common fine prominent dark brown (7.5YR 4/4) mottles; moderate fine prismatic structure; firm; few thin discontinuous clay films on faces of peds; few fine black concretions (oxides); neutral; gradual smooth boundary.

C1—47 to 62 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent dark brown (7.5YR 4/4) mottles; massive; firm; neutral; gradual smooth boundary.

C2—62 to 74 inches; light brownish gray (2.5Y 6/2) silty clay loam; few fine and medium prominent strong brown (7.5YR 5/8) mottles; massive; firm; neutral.

The solum is 41 to 56 inches thick. The mollic epipedon is 11 to 17 inches thick.

The A horizon dominantly has hue of 10YR, value of 2, and chroma of 1, but in some pedons it has value of 3 and chroma of 2. It is silt loam or silty clay loam. The B2 horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 through 3. The B3 and C horizons have hue of 10YR through 5Y, value of 4 through 6, and chroma of 1 or 2.

The thin dark colored surface layer of Grundy silty clay loam, 2 to 5 percent slopes, eroded, and Grundy silty clay loam, 5 to 9 percent slopes, eroded, is outside the range defined for the series. However, this difference does not significantly affect the use and management of the soils.

Haig series

The Haig series consists of deep, poorly drained, slowly permeable soils on wide upland ridgetops. These soils formed in loess. Slopes range from 0 to 2 percent.

Haig soils are similar to Bremer soils and commonly are adjacent to Grundy soils. Bremer soils have a thicker mollic epipedon and have less clay in the B2 horizon than Haig soils. Grundy soils have a thinner mollic epipedon and do not have distinct or prominent mottles in the lower part of the mollic epipedon. They are in gently sloping areas downslope from Haig soils.

Typical pedon of Haig silt loam, 200 feet east and 330 feet north of the southwest corner of sec. 27, T. 57 N., R. 31 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; slightly acid; clear smooth boundary.

A3—10 to 15 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark brown (10YR 4/3) mottles; moderate very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21t—15 to 21 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; common fine distinct yellowish brown (10YR 5/4) and few fine prominent strong brown (7.5YR 5/8) mottles; moderate very fine and fine subangular blocky structure; firm; common thick continuous clay films on faces of peds; medium acid; gradual smooth boundary.

B22tg—21 to 31 inches; olive gray (5Y 4/2) silty clay, common fine prominent gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; moderate fine and medium prismatic structure; firm; many thick continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B23t—31 to 45 inches; grayish brown (2.5Y 5/2) silty clay; common fine prominent dark yellowish brown (10YR 4/4) mottles; moderate medium prismatic structure; firm; many thick continuous clay films on faces of peds; neutral; gradual smooth boundary.

B3t—45 to 58 inches; grayish brown (2.5Y 5/2) silty clay loam; many fine prominent dark brown (7.5YR 4/4) mottles; weak medium prismatic structure; firm; few thin discontinuous clay films on faces of peds; neutral; gradual smooth boundary.

C—58 to 74 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct and prominent yellowish brown (10YR 5/6) mottles; massive; firm; common fine black concretions (oxides); neutral.

The solum is 58 to more than 72 inches thick. The mollic epipedon is 20 to 25 inches thick.

The A horizon is medium acid to neutral. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 through 5, and chroma of 1 or 2.

Higginsville series

The Higginsville series consists of deep, somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 5 to 9 percent.

Higginsville soils are similar to Nevin soils and commonly are adjacent to Lamoni, Marshall, and Sharpsburg soils. Lamoni soils have more clay and glacial sand and pebbles throughout and are downslope

from Higginsville soils. Marshall and Sharpsburg soils do not have mottles of chroma of 2 in the upper part of the subsoil and are primarily on ridgetops or in moderately sloping areas at the end of ridges. Nevin soils have more sand throughout.

Typical pedon of Higginsville silt loam, 5 to 9 percent slopes, 990 feet south and 500 feet west of the northeast corner of sec. 28, T. 55 N., R. 32 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; friable; neutral; clear smooth boundary.

A12—9 to 13 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1t—13 to 17 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine faint dark brown (10YR 4/3) and few fine prominent yellowish brown (10YR 5/6) mottles; moderate very fine and fine subangular blocky structure; firm; common thin discontinuous very dark gray clay films on faces of peds; medium acid; gradual smooth boundary.

B21t—17 to 22 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine distinct and prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; common thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—22 to 31 inches; grayish brown (10YR 5/2) silty clay loam; common medium faint dark grayish brown (10YR 4/2) and few fine prominent strong brown (7.5YR 5/8) mottles; moderate medium prismatic structure; firm; many thick continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B3t—31 to 41 inches; grayish brown (10YR 5/2) silty clay loam; few fine prominent strong brown (7.5YR 5/8) mottles; weak medium prismatic structure; firm; few thin discontinuous clay films on faces of peds; slightly acid; gradual smooth boundary.

C—41 to 66 inches; grayish brown (10YR 5/2) silty clay loam; common fine prominent dark brown (7.5YR 4/4) and common fine faint brown (10YR 5/3) mottles; massive; firm; slightly acid.

The solum is 41 to 51 inches thick. The mollic epipedon is 11 to 17 inches thick.

The A horizon is slightly acid or neutral. The B2 horizon has hue of 10YR, value of 3 through 5, and chroma of 2 or 3. The C horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 1 or 2.

Kennebec series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on bottom lands. These soils formed in silty alluvial sediment. Slopes range from 0 to 2 percent.

Kennebec soils commonly are adjacent to Armstrong, Bremer, Gara, Gasconade, Lamoni, Nevin, Vanmeter, and Wiota soils. Armstrong, Gara, and Lamoni soils have glacial sand and pebbles throughout and are on uplands. Bremer, Nevin, and Wiota soils have more clay and are on terraces at a slightly higher elevation than Kennebec soils. Bremer soils are poorly drained, Nevin soils are somewhat poorly drained, and Wiota soils are moderately well drained. Gasconade and Vanmeter soils are on adjacent moderately sloping to very steep uplands. Gasconade soils are shallow, and Vanmeter soils are moderately deep.

Typical pedon of Kennebec silt loam, 1,450 feet south and 3,700 feet west of the northeast corner of sec. 33, T. 55 N., R. 32 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; neutral; clear smooth boundary.

A12—10 to 24 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; neutral; diffuse smooth boundary.

A13—24 to 40 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; neutral; diffuse smooth boundary.

C—40 to 63 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; few dark brown fine concretions (oxides); massive; friable; neutral.

The solum and mollic epipedon are 36 to 45 inches thick and slightly acid or neutral.

The Ap horizon typically has hue of 10YR, value of 3, and chroma of 2. The A1 horizon typically has hue of 10YR, value of 2, and chroma of 1 or 2. The C horizon has hue of 10YR, value of 3, and chroma of 1 or 2.

Ladoga series

The Ladoga series consists of deep, moderately well drained, moderately slowly permeable soils on narrow ridges. These soils formed in silty noncalcareous loess. Slopes range from 2 to 9 percent.

Ladoga soils are similar to Clinton, Gara, and Sharpsburg soils and commonly are adjacent to Armstrong, Clinton, Gara, Grundy, and Sharpsburg soils. Armstrong and Gara soils have glacial sand and pebbles throughout. Armstrong soils are downslope from Ladoga soils. Clinton soils have a lighter colored or a thinner dark colored surface layer. Grundy and Sharpsburg soils have a mollic epipedon. Grundy soils are on higher ridges than Ladoga soils.

Typical pedon of Ladoga silt loam, 5 to 9 percent slopes, 2,110 feet east and 500 feet north of the southwest corner of sec. 27, T. 55 N., R. 32 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; weak very fine granular structure; very friable; medium acid; abrupt smooth boundary.

B1t—7 to 10 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak very fine subangular blocky structure; firm; few thin patchy clay films on faces of peds; medium acid; clear smooth boundary.

B21t—10 to 17 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; firm; common thin discontinuous clay films on faces of peds; medium acid; clear smooth boundary.

B22t—17 to 26; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; firm; common thick discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B23t—26 to 40 inches; dark yellowish brown (10YR 4/4) silty clay loam; many fine distinct grayish brown (10YR 5/2) and few fine prominent strong brown (7.5YR 5/6) mottles; weak and moderate fine subangular blocky structure; firm; few thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B3—40 to 55 inches; mottled grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) silty clay loam; weak fine prismatic structure; firm; slightly acid; gradual smooth boundary.

C—55 to 65 inches; yellowish brown (10YR 5/4) silty clay loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; firm; slightly acid.

The solum is 41 to 55 inches thick. The very dark grayish brown surface layer is 6 to 9 inches thick.

The B2 horizon has hue of 10YR, value of 4, and chroma of 3 or 4. Content of clay ranges from 36 to 42 percent. The B3 and C horizons dominantly have hue of 10YR, value of 4 or 5, and chroma of 2 through 4. Below a depth of 36 inches, however, the range includes hue of 5Y, value of 4 or 5, and chroma of 2.

Lamoni series

The Lamoni series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in weathered glacial till. Slopes range from 5 to 14 percent.

Lamoni soils are similar to Grundy soils and commonly are adjacent to Colo, Grundy, Higginsville, Sharpsburg, and Shelby soils. Grundy, Higginsville, and Sharpsburg soils do not have sand and glacial pebbles in the subsoil and are upslope from Lamoni soils. Shelby soils are well drained. They have less clay than Lamoni soils and are not mottled in the upper part of the B horizon. They are in steeper areas downslope from Lamoni soils. Colo soils are poorly drained and have a cumulic mollic epipedon. They also have less clay than Lamoni soils; they are on narrow bottoms downslope from Lamoni soils.

Typical pedon of Lamoni silty clay loam, 5 to 9 percent slopes, 1,450 feet north and 920 feet west of the southeast corner of sec. 20, T. 57 N., R. 32 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—7 to 11 inches; very dark gray (10YR 3/1) clay loam, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

IIB1t—11 to 16 inches; dark grayish brown (10YR 4/2) clay loam; few fine prominent strong brown (7.5YR 5/8) mottles; moderate fine subangular blocky structure; firm; very dark gray stains on faces of peds; few thin patchy clay films on faces of peds; strongly acid; clear smooth boundary.

IIB21t—16 to 23 inches; dark grayish brown (10YR 4/2) clay; few fine prominent red (2.5YR 5/8) and strong brown (7.5YR 5/8) mottles; moderate medium subangular blocky structure; firm; common thin continuous clay films on faces of peds; strongly acid; gradual smooth boundary.

IIB22t—23 to 35 inches; grayish brown (2.5Y 5/2) clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate coarse angular blocky structure; firm; common thin continuous clay films on faces of peds; neutral; gradual smooth boundary.

IIB23t—35 to 44 inches; grayish brown (2.5Y 5/2) clay; common medium prominent yellowish brown (10YR 5/6) mottles; moderate coarse angular blocky structure; firm; few thin discontinuous clay films on faces of peds; neutral; gradual smooth boundary.

IIB3t—44 to 60 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct light gray (10YR 6/1) mottles and common medium prominent strong brown (7.5YR 5/6) mottles; weak medium angular blocky structure; firm; mildly alkaline.

The solum is 52 to more than 60 inches thick. The mollic epipedon is 10 to 14 inches thick.

The A1 or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly silty clay loam, although the range includes loam and clay loam. The upper part of the IIB horizon has hue of 10YR, value of 4, and chroma of 2. It has strong brown or yellowish brown mottles. In many pedons it also has yellowish red or red mottles. The lower part of the IIB horizon typically has a matrix that has hue of 10YR through 5Y, value of

5 or 6, and chroma of 1 through 6. It has mottles of other colors. In some places there is a C horizon that is neutral to moderately alkaline and has soft masses of calcium.

The thin dark colored surface layer of Lamoni silty clay loam, 5 to 9 percent slopes, eroded, is outside the range defined for the series. However, this difference does not significantly affect the use and management of the soil.

Marshall series

The Marshall series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 9 percent.

Marshall soils are similar to Sharpsburg and Wiota soils and commonly are adjacent to Colo, Higginsville, and Sharpsburg soils. Colo soils are poorly drained and are on small narrow drainageways. Higginsville soils are somewhat poorly drained and are at the head of drainageways downslope from Marshall soils. Sharpsburg soils are moderately well drained. They have more clay and have more mottles with chroma of 2 in the lower part of the B horizon. Wiota soils have an argillic horizon.

Typical pedon of Marshall silt loam, 2 to 5 percent slopes, in a cultivated field, 1,190 feet east and 3,035 feet south of the northwest corner of sec. 10, T. 55 N., R. 33 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; neutral; abrupt smooth boundary.

A12—9 to 15 inches; very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 4/3) dry; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.

B1—15 to 19 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21t—19 to 25 inches; brown (10YR 4/3) silty clay loam; weak fine subangular blocky structure; friable; few thin discontinuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—25 to 35 inches; brown (10YR 4/3) silty clay loam; weak fine prismatic structure; friable; few thin discontinuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B3—35 to 48 inches; yellowish brown (10YR 5/4) silty clay loam; few fine distinct grayish brown (10YR 5/2) mottles; weak fine prismatic structure; friable; slightly acid; gradual smooth boundary.

C—48 to 72 inches; yellowish brown (10YR 5/4) silty clay loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; friable; slightly acid.

The solum is 46 to 63 inches thick. The mollic epipedon is 12 to 21 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly silt loam, although the range includes silty clay loam. The B2 horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It ranges from medium acid to neutral. The C horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It has common to many grayish brown mottles.

Nevin series

The Nevin series consists of deep, somewhat poorly drained, moderately permeable soils on low stream terraces and high second bottoms. These soils formed in silty sediments. Slope is generally less than 2 percent.

Nevin soils are similar to Higginsville soils and commonly are adjacent to Bremer, Kennebec, Nodaway, and Wiota soils. Bremer soils are poorly drained. They have more clay and are in positions similar to those of Nevin soils but slightly lower. Higginsville soils have less sand. Kennebec and Nodaway soils are moderately well drained and are in lower positions adjacent to stream channels. Wiota soils are moderately well drained. They do not have chroma 2 colors in the upper part of the subsoil. They are in slightly higher positions than Nevin soils.

Typical pedon of Nevin silt loam, 450 feet east and 1,450 feet south of the northwest corner of sec. 22, T. 56 N., R. 30 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—9 to 18 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—18 to 26 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine prominent dark brown (7.5YR 4/4) and few fine faint grayish brown mottles; weak very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21t—26 to 35 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine prominent dark brown (7.5YR 4/4) mottles; weak very fine and fine subangular blocky structure; firm; few thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—35 to 42 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) silty clay loam; common fine prominent strong brown (7.5YR 5/8) mottles; weak very fine prismatic structure; firm; few thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

B3—42 to 51 inches; grayish brown (10YR 5/2) silty clay loam; common fine prominent strong brown (7.5YR 5/8) mottles; weak very fine prismatic structure; friable; slightly acid; gradual smooth boundary.

C—51 to 65 inches; grayish brown (10YR 5/2) silty clay loam; many fine prominent strong brown (7.5YR 5/8) mottles; massive; friable; neutral.

The solum is 45 to 58 inches thick. The mollic epipedon is 18 to 26 inches thick.

The B and C horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. They have mottles or have a chroma 2 matrix.

Nodaway series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on bottom lands. These soils formed in silty alluvial sediment. Slopes range from 0 to 2 percent.

Nodaway soils commonly are adjacent to Armstrong, Bremer, Gara, Nevin, Vanmeter, and Wiota soils. Armstrong and Gara soils have glacial sand and pebbles throughout and are on uplands. Bremer soils are poorly drained and are on low terraces. Nevin soils are somewhat poorly drained. They have more clay and are on terraces in slightly higher positions than Nodaway soils. Vanmeter soils are moderately deep. They have more clay and are on moderately sloping to very steep uplands adjacent to the flood plains. Wiota soils have more clay and are on terraces in slightly higher positions than Nodaway soils.

Typical pedon of Nodaway silt loam, 990 feet south and 110 feet east of the center of sec. 29, T. 56 N., R. 32 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; very friable; slightly acid; abrupt smooth boundary.

C1—8 to 28 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; many splotches and very thin strata of grayish brown (10YR 5/2) silt loam; massive; very friable; neutral; clear smooth boundary.

C2—28 to 44 inches; very dark grayish brown (10YR 3/2) silt loam; many thin strata of dark grayish brown (10YR 4/2) silt loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; massive; very friable; neutral; gradual smooth boundary.

C3—44 to 65 inches; stratified very dark gray (10YR 3/1), dark grayish brown (10YR 4/2), and grayish brown (10YR 5/2) silt loam; massive; very friable; neutral.

The sequence and thickness of strata in the C horizon vary. The C horizon typically has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It has thin strata of hue of 10YR, value of 5, and chroma of 2. In some pedons a few very thin strata of sand are above a depth of 40 inches, and sandy strata more than 1 inch thick are commonly below a depth of 40 inches.

Sharpsburg series

The Sharpsburg series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 9 percent.

Sharpsburg soils are similar to Marshall and Wiota soils and commonly are adjacent to Higginsville and Lamoni soils. Higginsville soils are grayer than Sharpsburg soils. They have less clay in the subsoil and are on lower slopes. Lamoni soils have more clay, sand, and pebbles in the subsoil and are downslope from Sharpsburg soils. Marshall soils have less clay and do not have an argillic horizon. Wiota soils have less clay in the subsoil.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, 420 feet south and 500 feet west of the northeast corner of sec. 28, T. 55 N., R. 32 W.

A1—0 to 9 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; neutral; clear smooth boundary.

A12—9 to 12 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A3—12 to 16 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; firm; medium acid; clear smooth boundary.

B21t—16 to 20 inches; dark brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; firm; few thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—20 to 25 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine prominent grayish brown (2.5Y 5/2) mottles in lower part; moderate medium subangular blocky structure; firm; many moderately thick continuous clay films on faces of peds; medium acid; gradual smooth boundary.

B23t—25 to 33 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine prominent grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure; firm; common thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B3—33 to 53 inches; yellowish brown (10YR 5/4) silty clay loam; common medium prominent grayish brown (2.5Y 5/2) mottles; weak fine prismatic structure; firm; medium acid; gradual smooth boundary.

C—53 to 75 inches; mottled yellowish brown (10YR 5/4) and grayish brown (2.5Y 5/2) silty clay loam; massive; firm; slightly acid.

The solum is 42 to 53 inches thick. The mollic epipedon is 11 to 17 inches thick.

The A horizon is dominantly silty clay loam, although the range includes silt loam. The B2t horizon has hue of 10YR, value of 4, and chroma of 3 or 4. The B3 and C horizons have hue of 10YR, 2.5Y, or 5Y, value of 4 through 6, and chroma of 2 through 4.

Shelby series

The Shelby series consists of deep, moderately well drained, moderately permeable soils on uplands. These soils formed in clay loam glacial till. Slopes range from 9 to 14 percent.

Shelby soils are similar to Gara soils and commonly are adjacent to Colo and Lamoni soils. Colo soils have a cumulic mollic epipedon and have less clay, sand, and pebbles. They are in narrow drainageways adjacent to Shelby soils. Gara soils do not have a mollic epipedon. Lamoni soils have a fine textured B horizon and have chroma 2 colors in the upper part. They are upslope from Shelby soils.

Typical pedon of Shelby loam, 9 to 14 percent slopes, 1,380 feet north and 2,320 feet west of the southeast corner of sec. 27, T. 57 N., R. 33 W.

A1—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine granular structure; very friable; slightly acid; abrupt smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A3—11 to 16 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; few fine faint brown mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

B21t—16 to 20 inches; dark brown (10YR 4/3) clay loam, some ped exteriors are very dark grayish brown (10YR 3/2); moderate fine subangular blocky structure; firm; few thin patchy clay films on faces of peds; slightly acid; clear smooth boundary.

B22t—20 to 25 inches; dark yellowish brown (10YR 4/4) clay loam; few fine faint yellowish brown mottles; moderate fine subangular blocky structure; firm; common thin discontinuous clay films on faces of peds; slightly acid; clear smooth boundary.

B3t—25 to 32 inches; yellowish brown (10YR 5/4) clay loam; weak fine prismatic structure; firm; few thin patchy clay films on faces of peds; slightly acid; clear smooth boundary.

C1—32 to 39 inches; yellowish brown (10YR 5/4) clay loam; massive; firm; few small masses of calcium; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—39 to 60 inches; yellowish brown (10YR 5/4) clay loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; firm; common small masses of calcium; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates are 32 to 49 inches. The mollic epipedon is 11 to 16 inches thick.

The A horizon is dominantly loam, although the range includes clay loam. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The C horizon has hue of 10YR, value of 5, and chroma of 4 through 6. It has common or many mottles with hue of 10YR, value of 5, and chroma of 2. In some pedons the C horizon has large splotches of hue of 10YR, value of 5, and chroma of 2.

Vanmeter series

The Vanmeter series consists of moderately deep, moderately well drained, very slowly permeable soils on dissected uplands along major drainageways. These soils formed in residuum of shale. Slopes range from 9 to 50 percent.

Vanmeter soils commonly are adjacent to Gara, Gasconade, and Nodaway soils. Gara soils are deep, have glacial sand and pebbles throughout, and are in less sloping areas at a higher elevation than Vanmeter soils. Gasconade soils are shallow to limestone bedrock. They are on steep side slopes in positions similar to those of Vanmeter soils but at a higher elevation. Nodaway soils are deep, have a silt loam texture, and are on flood plains.

Typical pedon of Vanmeter silty clay loam, in an area of Vanmeter-Gasconade complex, 14 to 50 percent slopes, 3,100 feet west and 3,350 feet south of the northeast corner of sec. 19, T. 54 N., R. 30 W.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky and strong fine granular structure; firm; common very fine, fine, and medium roots and few coarse roots; about 5 percent limestone fragments 1/2 inch to 6 inches long and 10 percent fragments 6 to 15 inches long; neutral; abrupt smooth boundary.

B1—3 to 7 inches; dark brown (10YR 4/3) silty clay loam; moderate very fine subangular blocky structure; firm; common fine and few coarse roots; coarse fragments approximately the same as those in the A1 horizon; neutral; clear smooth boundary.
B21—7 to 11 inches; dark yellowish brown (10YR 4/4) silty clay; moderate very fine and fine subangular blocky structure; firm; common medium and few coarse roots; coarse fragments approximately the same as those in the A1 horizon; neutral; clear smooth boundary.
B22—11 to 17 inches; olive brown (2.5Y 4/4) silty clay; moderate fine subangular blocky structure; firm; common medium and few coarse roots; few weathered shale fragments 1/4 to 1/2 inch thick and as much as 6 inches wide; mildly alkaline; clear smooth boundary.
B3—17 to 22 inches; yellowish brown (10YR 5/4) silty clay; weak medium subangular blocky structure; firm; roots and fragments the same as those in the B22 horizon; mildly alkaline; clear smooth boundary.
C1—22 to 36 inches; olive gray (5Y 5/2) silty clay; massive; firm; roots and fragments the same as those in the B22 horizon; mildly alkaline; strong effervescence; clear smooth boundary.
Cr—36 to 57 inches; olive (5Y 5/3) and olive gray (5Y 4/2) soft shale; thin platy rock structure; few medium and coarse roots; mildly alkaline; strong effervescence; clear smooth boundary.
R—57 inches; shale bedrock; upper 4 inches rippable with much difficulty.

The solum is 20 to 36 inches thick.

The A horizon is silt loam or silty clay loam. The B2 horizon has hue of 7.5YR through 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is silty clay loam or silty clay. The Cr horizon has hue of 7.5YR through 5Y, value of 4 or 5, and chroma of 2 through 6.

Wiota series

The Wiota series consists of deep, moderately well drained, moderately permeable soils on low stream terraces and high second bottoms. These soils formed in silty sediment. Slope is generally less than 2 percent.

Wiota soils are similar to Marshall and Sharpsburg soils and commonly are adjacent to Bremer, Kennebec, Nevin, and Nodaway soils. Bremer and Nevin soils have grayer colors than Wiota soils. Bremer soils have more clay in the upper part of the subsoil and are in similar but slightly lower positions. Kennebec and Nodaway soils have less clay and are in lower positions on bottom lands. Marshall soils do not have an argillic horizon. Sharpsburg soils have more clay in the subsoil.

Typical pedon of Wiota silt loam, 1,120 feet east and 1,780 feet north of the southwest corner of sec. 12, T. 55 N., R. 33 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; neutral; clear smooth boundary.
A12—8 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
A3—13 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; firm; neutral; gradual smooth boundary.
B21t—20 to 30 inches; dark brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; firm; very dark grayish brown (10YR 3/2) coatings on faces of peds; slightly acid; gradual smooth boundary.
B22t—30 to 39 inches; dark brown (10YR 4/3) silty clay loam; few fine faint grayish brown and few fine prominent yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.
B23t—39 to 49 inches; dark brown (10YR 4/3) silty clay loam; common fine prominent yellowish brown (10YR 5/8) mottles; moderate medium prismatic structure; firm; dark grayish brown streaks in cracks; slightly acid; clear smooth boundary.
B3—49 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine prominent strong brown (7.5YR 5/8) mottles; weak medium prismatic structure; firm; slightly acid.

The solum is 45 to 60 inches thick. The mollic epipedon is 18 to 24 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly silt loam, although the range includes silty clay loam. The B2t horizon has hue of 10YR, value of 4, and chroma of 3 or 4. Mottles of higher or lower chroma are in the lower part.

formation of the soils

This section describes the factors of soil formation and relates them to the formation of soils in the survey area.

factors of soil formation

Soil is the product of soil forming processes acting on materials accumulated or deposited by geologic action. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and in extreme cases determines it almost entirely. Finally, time is needed to change the parent material into a soil that has distinct horizons. Although it varies, some time is always required for differentiation of soil horizons. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

parent material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineral composition of the soil. In Clinton County, the soils formed in loess, glacial till, alluvium, or residual material or in a combination of these parent materials.

Loess is wind-deposited silty material probably blown from the larger flood plains. Loess remains on most of the wider ridges and is as much as 10 feet thick in some areas. In Clinton County, Clinton, Grundy, Higginsville, Haig, Ladoga, Marshall, and Sharpsburg soils formed in loess.

Before loess was deposited, thick layers of glacial till were deposited over the bedrock of the county. This material is generally yellowish brown and is a heterogeneous mass of sand, silt, clay, and rock material ranging in size from small pebbles to boulders. The glacial till ranges from a few feet to more than 300 feet in thickness. In some areas, soil formed in glacial till before loess was deposited. The areas are generally narrow, and the surface layer, which formed at a later time, varies in thickness. Armstrong, Clarinda, and Lamoni soils formed in these areas. In steeper areas, unweathered glacial material was later exposed by geologic erosion. Gara and Shelby soils formed in this material.

Alluvium is water-transported soil material that was deposited on nearly level flood plains of streams. Most of this material was eroded from the surrounding upland soils. The material ranges from clay and silt to fine sand. Colo soils formed in the clayey material, and Kennebec and Nodaway soils formed in the more silty alluvial material.

Residual material in Clinton County consists of material weathered from shale and limestone beds. The limestone layers generally are above the shale. Gasconade and Vanmeter soils formed in residual material.

climate

Climate has been an important factor in the formation of soils in Clinton County. Variations in the climate in the past one million years have drastically affected conditions in the area.

The present climate in Clinton County is subhumid midcontinental and has changed little for the past 6,500 years. This period has been drier than previous ones and more favorable for native prairie grasses. Most of the soils in the county have a dark colored upper layer, which indicates that they formed under prairie vegetation. Grundy, Higginsville, Marshall, and Sharpsburg soils are examples of such soils.

The period before the present one, 6,500 to 20,000 years ago, was cool and moist (*10*). This climate was favorable to the growth of forest vegetation. During the following drier period, forest vegetation diminished except for the areas nearer the streams. Soils that formed under transitional prairie-timber vegetation have a

moderately thick dark surface layer. Armstrong, Gara, and Ladoga soils formed under transitional vegetation.

The glacial periods resulted from changes in climate. Thousands of years of cooler temperatures caused the massive glaciers of the Nebraskan and Kansan ages. Later, warmer temperatures caused catastrophic geological erosion and the blowing of the loess that covered most of Clinton County at one time. Because extreme changes in climate come about very slowly, there were long intermediate periods characterized by different types of vegetation. Soils formed on the surface and were later covered by loess, truncated, mixed by erosion, or completely eroded away. Some soils formed mostly in these old truncated or weathered surfaces. Armstrong and Lamoni soils are examples of such soils.

The prevailing winds are from the southwest. Most of the loess, therefore, was blown in a northeasterly direction, probably from the bottom land of the Missouri River and other large streams. The distance that loess is carried by the wind depends of the particle size. Most of the loess that covered Clinton County was fine silt and clay size particles. Clinton, Grundy, Higginsville, Haig, Marshall, and Sharpsburg soils formed in loess.

Local conditions can modify the influence of the general climate in a region. South-facing slopes are warmer and drier than north-facing slopes. Low-lying, poorly drained soils on bottom lands stay wetter and cooler longer than those in surrounding higher areas. These local differences influence the characteristics of the soil and account for some of the local differences among soils.

plants and animals

Plants, burrowing animals, insects, bacteria, and fungi are important in the formation of soils. They affect the organic matter, plant nutrients, structure, and porosity of soils.

Many of the soils in Clinton County formed mainly under tall prairie grasses. These soils, generally known as "prairie soils," have a thick dark surface layer that is high in organic matter because of abundant bacteria and decaying fine grass roots. Grundy, Haig, Lamoni, Higginsville, Marshall, Sharpsburg, and Shelby soils formed on uplands under prairie grasses.

Soils that formed under forest vegetation have a thin dark surface layer. Clinton and Vanmeter soils formed under forest vegetation.

Several soils in Clinton County have been influenced by both grass and trees. These soils have properties intermediate between those formed under grass and those formed under trees and are generally known as "transitional soils." Armstrong, Gara, and Ladoga soils formed under grass and trees.

Worms, insects, burrowing animals, large animals, and man all affect and disturb the soil. However, bacteria and fungi contribute more to the formation of soils than do animals. Bacteria and fungi cause rotting of organic materials, improve tilth, and fix nitrogen in the soils. The population of soil organisms is directly related to the rate of decomposition of organic matter in the soil. Differences in vegetation influence the kinds of organisms and their activity.

Man has greatly influenced the soils in this county. Intensive cultivation and overgrazing have resulted in severe erosion in many areas. As much as 15 inches of topsoil has been lost. Many acres of soil are still eroding at a rate in excess of what is considered tolerable to sustain production.

relief

Relief influences soil formation mostly through its effect on drainage, runoff, erosion, and, to some extent, exposure to sun and wind.

The amount of water entering and passing through the soil depends upon the steepness of the slope, the permeability of the soil material, and the amount and intensity of rainfall. On steep soils, runoff is rapid, and very little water passes through the soil. Consequently, distinct horizons do not develop. On gently sloping or nearly level soils, runoff is slow, and most of the water passes through the soil. As a result, these soils show maximum profile development. If slopes are similar, soils that have rapid permeability form more slowly than soils that have slow permeability.

In general, soils that formed in similar material are more droughty on steeper south-facing slopes than on north-facing slopes. This difference results from more direct sunlight. Droughtiness influences soil formation through its effect on the amount and kind of vegetation, erosion, and freezing and thawing.

time

The degree of profile development reflects the length of time the parent material has been in place and subjected to weathering processes. Young soils show very little profile development or horizon differentiation. Old soils show the effects of the movement of clay and leaching and have distinct horizons that are readily observable.

The youngest soils in Clinton County are those that formed in alluvium. Nodaway soils do not show any profile development. Alluvial material is added to the surface nearly every year. Bremer soils are the oldest alluvial soils. They are on terraces and show moderate profile development.

Some of the older soils in the county are Gara and Shelby soils (*10*). These soils formed on recently dissected slopes of the Late Wisconsin age, probably 11,000 to 14,000 years ago. Grundy, Haig, Ladoga, Marshall, and Sharpsburg soils formed in loess material of the Early Wisconsin age, probably 14,000 to 16,000 years ago.

The oldest soils in the county are Armstrong, Clarinda, and Lamoni soils. Armstrong soils formed in weathered

material of the Late Sangamon age, about 38,000 years ago. Clarinda and Lamoni soils formed in material of the Yarmouth interglacial period, more than 150,000 years ago (*10*).

In some areas rocky residual material has been exposed by geological erosion. This material is very old; however, the soils in these areas show little profile development because of steep slopes and the shallowness of the material. The shallow Gasconade soil and the moderately deep Vanmeter soil are examples of soils that formed in this material.

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glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compact layers to depths below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the

soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Narrow-base terrace. A terrace no more than 4 to 8 feet wide at the base. A narrow-base terrace is similar to a broad-base terrace, except for the width of the ridge and channel.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on

features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and

clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland(geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occuring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Constrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1952-79 at St. Joseph, Missouri]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	34.5	14.7	24.6	62	-14	0	.98	.25	1.55	3	5.9
February----	41.6	20.9	31.3	70	-7	16	.97	.29	1.50	3	4.2
March-------	52.2	30.3	41.3	83	3	66	2.28	.77	3.52	5	4.9
April-------	66.5	43.1	54.8	90	22	188	3.09	1.76	4.27	6	.6
May---------	76.3	53.7	65.0	92	33	470	4.64	2.55	6.47	7	.0
June--------	85.5	63.3	74.4	99	46	732	4.89	2.54	6.94	8	.0
July--------	89.4	67.3	78.4	102	50	880	3.83	1.16	5.98	6	.0
August------	87.2	64.7	76.0	100	48	806	3.89	1.63	5.80	6	.0
September---	79.7	55.9	67.8	96	36	534	4.11	1.47	6.29	6	.0
October-----	69.8	44.2	57.0	91	24	253	2.68	.53	4.38	5	.0
November----	53.1	31.7	42.4	78	10	23	1.66	.24	2.72	3	.6
December----	40.4	21.7	31.1	66	-6	0	1.04	.35	1.60	3	4.3
Yearly:											
Average--	64.7	42.6	53.7	---	---	---	---	---	---	---	---
Extreme--	---	---	---	102	-15	---	---	---	---	---	---
Total----	---	---	---	---	---	3,968	34.06	26.09	41.53	61	20.5

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature (50° F) below which growth is minimal for the principal crops in the area.

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1952-79 at St. Joseph, Missouri]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 10	April 21	May 4
2 years in 10 later than--	April 5	April 16	April 29
5 years in 10 later than--	March 25	April 6	April 19
First freezing temperature in fall:			
1 year in 10 earlier than--	October 23	October 12	September 30
2 years in 10 earlier than--	October 28	October 17	October 5
5 years in 10 earlier than--	November 6	October 27	October 16

TABLE 3.--GROWING SEASON

[Recorded in the period 1952-79 at St. Joseph, Missouri]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	203	181	157
8 years in 10	211	189	165
5 years in 10	226	204	179
2 years in 10	242	219	193
1 year in 10	250	227	201

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1B	Marshall silt loam, 2 to 5 percent slopes	2,150	0.8
1C	Marshall silt loam, 5 to 9 percent slopes	1,750	0.6
5C2	Clinton silt loam, 5 to 9 percent slopes, eroded	2,900	1.1
7B	Sharpsburg silty clay loam, 2 to 5 percent slopes	19,500	7.2
7C	Sharpsburg silty clay loam, 5 to 9 percent slopes	4,600	1.7
8C	Higginsville silt loam, 5 to 9 percent slopes	18,600	6.9
13	Haig silt loam	1,150	0.4
14B	Grundy silt loam, 2 to 5 percent slopes	40,000	14.9
14B2	Grundy silty clay loam, 2 to 5 percent slopes, eroded	5,900	2.2
14C	Grundy silt loam, 5 to 9 percent slopes	29,250	10.9
14C2	Grundy silty clay loam, 5 to 9 percent slopes, eroded	11,100	4.1
16B	Ladoga silt loam, 2 to 5 percent slopes	2,100	0.8
16C	Ladoga silt loam, 5 to 9 percent slopes	6,700	2.5
22	Wiota silt loam	1,100	0.4
23	Bremer silty clay loam	3,400	1.3
24	Nevin silt loam	2,700	1.0
26D	Vanmeter silt loam, 9 to 14 percent slopes	1,500	0.6
29F	Vanmeter-Gasconade complex, 14 to 50 percent slopes	4,950	1.8
33C	Armstrong loam, 5 to 9 percent slopes	22,000	8.2
33D	Armstrong clay loam, 9 to 14 percent slopes	7,200	2.7
34C3	Armstrong clay loam, 5 to 9 percent slopes, severely eroded	700	0.3
34D3	Armstrong clay loam, 9 to 14 percent slopes, severely eroded	225	0.1
37D	Gara loam, 9 to 14 percent slopes	15,700	5.8
37E	Gara loam, 14 to 20 percent slopes	2,850	1.1
39C2	Clarinda silty clay loam, 5 to 9 percent slopes, eroded	1,000	0.4
42C	Lamoni silty clay loam, 5 to 9 percent slopes	15,800	5.9
42C2	Lamoni silty clay loam, 5 to 9 percent slopes, eroded	14,600	5.4
42D	Lamoni silty clay loam, 9 to 14 percent slopes	810	0.3
44D	Shelby loam, 9 to 14 percent slopes	2,050	0.8
52	Kennebec silt loam	5,400	2.0
55B	Colo silty clay loam, 2 to 5 percent slopes	14,000	5.2
61	Nodaway silt loam	5,700	2.1
99	Pits, quarry	495	0.2
	Water	920	0.3
	Total	268,800	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Grain sorghum	Winter wheat	Grass-legume hay	Bromegrass-alfalfa
	Bu	Bu	Bu	Bu	Ton	AUM*
1B Marshall	107	41	92	44	4.5	7.5
1C Marshall	102	39	85	41	4.3	7.1
5C2 Clinton	85	33	74	36	3.8	6.4
7B Sharpsburg	101	38	87	42	4.7	7.2
7C Sharpsburg	94	35	81	39	4.5	6.8
8C Higginsville	108	41	94	45	4.8	6.8
13 Haig	96	36	83	40	4.2	7.0
14B Grundy	98	38	85	40	4.4	6.8
14B2 Grundy	94	35	80	38	4.2	6.5
14C Grundy	90	34	77	37	4.0	6.1
14C2 Grundy	80	30	68	34	3.6	6.6
16B Ladoga	91	34	78	37	4.0	6.6
16C Ladoga	84	31	72	35	3.8	6.5
22 Wiota	110	42	95	45	4.6	7.6
23 Bremer	96	36	83	40	4.2	7.0
24 Nevin	114	43	95	47	4.8	8.0
26D Vanmeter	---	---	---	---	2.7	4.5
29F Vanmeter-Gasconade	---	---	---	---	---	---
33C Armstrong	67	25	59	29	2.7	4.5
33D Armstrong	58	22	50	24	2.3	3.8
34C3 Armstrong	52	20	44	21	2.0	3.3

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Grain sorghum	Winter wheat	Grass-legume hay	Bromegrass-alfalfa
	Bu	Bu	Bu	Bu	Ton	AUM*
34D3 Armstrong	---	---	---	---	1.4	2.3
37D Gara	74	27	64	31	3.3	5.5
37E Gara	---	---	---	---	2.5	4.1
39C2 Clarinda	50	17	47	21	2.2	3.6
42C Lamoni	76	29	66	32	3.2	5.3
42C2 Lamoni	71	27	62	30	3.0	5.0
42D Lamoni	66	25	58	29	2.7	4.5
44D Shelby	84	32	73	35	3.5	5.8
52 Kennebec	105	40	86	42	5.1	7.2
55B Colo	102	39	83	40	4.0	6.6
61 Nodaway	98	37	85	41	4.6	7.0
99. Pits						

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
1B, 1C Marshall	---	-------	-------	-------	-------	------------------	---	Black walnut, eastern white pine, green ash, sugar maple.
5C2 Clinton	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	65 ---	Eastern white pine, black walnut, northern red oak, white oak.
7B, 7C Sharpsburg	---	-------	-------	-------	-------	------------------	---	Black walnut, green ash, white oak, northern red oak.
8C Higginsville	---	-------	-------	-------	-------	------------------	---	Pecan, eastern cottonwood, pin oak, yellow-poplar, silver maple, American sycamore, green ash.
13 Haig	---	-------	-------	-------	-------	------------------	---	Pin oak, pecan, green ash, eastern cottonwood.
14B, 14B2, 14C, 14C2 Grundy	---	-------	-------	-------	-------	------------------	---	Eastern cottonwood, pin oak, silver maple, green ash.
16B, 16C Ladoga	2o	Slight	Slight	Slight	Slight	White oak Northern red oak	75 75	Eastern white pine, white oak, northern red oak, black walnut, sugar maple.
22 Wiota	---	-------	-------	-------	-------	------------------	---	Black walnut, green ash, northern red oak.
23 Bremer	3w	Slight	Severe	Moderate	Moderate	Eastern cottonwood Silver maple	90 80	American sycamore, hackberry, green ash, eastern cottonwood, silver maple.
24 Nevin	---	-------	-------	-------	-------	------------------	---	Pin oak, eastern cottonwood, pecan.
26D Vanmeter	5c	Slight	Slight	Severe	Severe	White oak Northern red oak Hickory White ash Sugar maple	45 --- --- --- ---	White ash, eastern redcedar.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
29F: Vanmeter	5c	Severe	Severe	Severe	Severe	White oak	45	White ash, eastern redcedar.
						Northern red oak	---	
						Butternut	---	
						Hickory	---	
						White ash	---	
						Sugar maple	---	
Gasconade	5d	Slight	Severe	Moderate	Moderate	Eastern redcedar	30	Eastern redcedar, white ash.
						Chinkapin oak	---	
						White ash	---	
						Sugar maple	---	
						Mockernut hickory	---	
						Post oak	---	
						Blackjack oak	---	
33C, 33D, 34C3, 34D3: Armstrong	4c	Slight	Slight	Severe	Severe	White oak	55	Eastern white pine, white oak, northern red oak, pin oak, green ash, sugar maple.
						Northern red oak	55	
37D: Gara	3o	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, white oak, northern red oak, pin oak.
						Northern red oak	55	
37E: Gara	3r	Moderate	Moderate	Slight	Slight	White oak	55	Eastern white pine, white oak, northern red oak, pin oak.
						Northern red oak	55	
39C2: Clarinda	---	---	---	---	---	---	---	Pin oak, eastern cottonwood, hackberry.
42C, 42C2, 42D: Lamoni	---	---	---	---	---	---	---	Pin oak, green ash, eastern cottonwood.
44D: Shelby	---	---	---	---	---	---	---	Black walnut, green ash.
52: Kennebec	2o	Slight	Slight	Slight	Slight	Black walnut	79	Black walnut, green ash, eastern cottonwood, American sycamore.
						Bur oak	63	
						Hackberry	---	
						Green ash	---	
						Eastern cottonwood	---	
55B: Colo	---	---	---	---	---	---	---	Pecan, eastern cottonwood.
61: Nodaway	2o	Slight	Slight	Slight	Slight	White oak	75	Eastern white pine, green ash, black walnut.
						Black walnut	76	
						American elm	---	
						Green ash	---	

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1B, 1C. Marshall	---	Silky dogwood, Amur honeysuckle, Amur privet, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Pin oak, eastern white pine.
5C2. Clinton	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
7B, 7C. Sharpsburg	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
8C. Higginsville	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Austrian pine, pin oak, Scotch pine, green ash, red pine.	Eastern cottonwood, eastern white pine.
13. Haig	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	Norway spruce, Austrian pine, blue spruce, white fir, northern white-cedar, Washington hawthorn.	Eastern white pine	Pin oak.
14B, 14B2, 14C, 14C2. Grundy	---	Washington hawthorn, Tatarian honeysuckle, Amur honeysuckle, Amur privet, American cranberrybush, arrowwood, eastern redcedar.	Austrian pine, osageorange, green ash.	Pin oak, eastern white pine.	---
16B, 16C. Ladoga	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
22. Wiota	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
23. Bremer	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	Norway spruce, Austrian pine, blue spruce, white fir, northern white-cedar, Washington hawthorn.	Eastern white pine	Pin oak.
24. Nevin	---	Silky dogwood, Amur privet, American cranberrybush, Amur honeysuckle.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
26D. Vanmeter					
29F: Vanmeter.					
Gasconade.					
33C, 33D, 34C3, 34D3 Armstrong	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Tatarian honeysuckle, Amur honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
37D, 37E Gara	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Northern white-cedar, white fir, Washington hawthorn, blue spruce.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
39C2 Clarinda	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Amur honeysuckle, Tatarian honeysuckle, American cranberrybush.	Green ash, osageorange.	Eastern white pine, pin oak, Austrian pine.	---
42C, 42C2, 42D Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
44D Shelby	---	Silky dogwood, American cranberrybush, Amur honeysuckle, Amur privet.	Washington hawthorn, northern white-cedar, blue spruce, white fir.	Norway spruce, Austrian pine.	Pin oak, eastern white pine.
52 Kennebec	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Northern white-cedar, Austrian pine, white fir, blue spruce, Washington hawthorn.	Norway spruce	Pin oak, eastern white pine.
55B. Colo					
61 Nodaway	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
99. Pits					

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1B Marshall	Slight	Slight	Moderate: slope.	Slight	Slight.
1C Marshall	Slight	Slight	Severe: slope.	Slight	Slight.
5C2 Clinton	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
7B Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
7C Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
8C Higginsville	Moderate: wetness.	Moderate: wetness.	Severe: slope.	Moderate: wetness.	Moderate: wetness.
13 Haig	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
14B, 14B2 Grundy	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
14C, 14C2 Grundy	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
16B Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
16C Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
22 Wiota	Severe: flooding.	Slight	Slight	Slight	Slight.
23 Bremer	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
24 Nevin	Severe: flooding.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
26D Vanmeter	Severe: percs slowly.	Severe: percs slowly.	Severe: slope, percs slowly.	Severe: erodes easily.	Moderate: slope.
29F:					
Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, erodes easily.	Severe: slope.
Gasconade	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, thin layer.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
33C Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
33D Armstrong	Severe: wetness.	Moderate: slope, wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
34C3 Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
34D3 Armstrong	Severe: wetness.	Moderate: slope, wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
37D Gara	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
37E Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
39C2 Clarinda	Severe: percs slowly, wetness.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness.
42C, 42C2 Lamoni	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
42D Lamoni	Severe: wetness.	Moderate: wetness, slope, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness, slope.
44D Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
52 Kennebec	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
55B Colo	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
61 Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
99. Pits					

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
1B Marshall	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1C Marshall	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
5C2 Clinton	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
7B Sharpsburg	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
7C Sharpsburg	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
8C Higginsville	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
13 Haig	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
14B, 14B2 Grundy	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
14C, 14C2 Grundy	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
16B Ladoga	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
16C Ladoga	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
22 Wiota	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
23 Bremer	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
24 Nevin	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
26D Vanmeter	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
29F:										
Vanmeter	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Gasconade	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
33C, 33D, 34C3, 34D3 Armstrong	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
37D Gara	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
37E Gara	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
39C2: Clarinda	Poor	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Very poor.
42C, 42C2, 42D: Lamoni	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
44D: Shelby	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
52: Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
55B: Colo	Good	Fair	Good	Fair	Fair	Fair	Very poor.	Fair	Fair	Poor.
61: Nodaway	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
99. Pits										

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1B: Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
1C: Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
5C2: Clinton	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
7B: Sharpsburg	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
7C: Sharpsburg	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
8C: Higginsville	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength, frost action.	Moderate: wetness.
13: Haig	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
14B, 14B2, 14C, 14C2: Grundy	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
16B: Ladoga	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
16C: Ladoga	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
22: Wiota	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
23: Bremer	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
24: Nevin	Severe: wetness.	Severe: flooding.	Severe: wetness, flooding.	Severe: flooding.	Severe: frost action, low strength.	Slight.
26D: Vanmeter	Moderate: slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.	Moderate: slope.
29F: Vanmeter	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
29F: Gasconade	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: large stones, slope, thin layer.
33C: Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
33D: Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action, shrink-swell.	Moderate: slope, wetness.
34C3: Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
34D3: Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action, shrink-swell.	Moderate: slope, wetness.
37D: Gara	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
37E: Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
39C2: Clarinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: frost action, low strength, shrink-swell.	Moderate: wetness.
42C, 42C2: Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.	Moderate: wetness.
42D: Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
44D: Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
52: Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
55B: Colo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action, shrink-swell.	Moderate: wetness, flooding.
61: Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
99. Pits						

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1B Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
1C Marshall	Slight	Severe: slope.	Slight	Slight	Good.
5C2 Clinton	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
7B Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
7C Sharpsburg	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
8C Higginsville	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
13 Haig	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
14B, 14B2 Grundy	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
14C, 14C2 Grundy	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
16B Ladoga	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
16C Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
22 Wiota	Moderate: flooding, percs slowly.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
23 Bremer	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
24 Nevin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
26D Vanmeter	Severe: depth to rock, percs slowly.	Severe: depth to rock. slope.	Severe: depth to rock.	Severe: depth to rock,	Poor: area reclaim, hard to pack.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
29F:					
Vanmeter	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, hard to pack, slope.
Gasconade	Severe: depth to rock, slope.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: area reclaim, too clayey, large stones.
33C, 33D, 34C3, 34D3 Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness.	Severe: wetness.	Poor: wetness.
37D Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
37E Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
39C2 Clarinda	Severe: wetness, percs slowly.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.
42C, 42C2, 42D Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
44D Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
52 Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
55B Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
61 Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
99. Pits					

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1B, 1C------------------ Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
5C2--------------------- Clinton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
7B, 7C------------------ Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
8C---------------------- Higginsville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
13---------------------- Haig	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
14B, 14B2, 14C, 14C2-- Grundy	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
16B, 16C---------------- Ladoga	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
22---------------------- Wiota	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
23---------------------- Bremer	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
24---------------------- Nevin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
26D--------------------- Vanmeter	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
29F:				
Vanmeter--------------	Poor: area reclaim, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
Gasconade-------------	Poor: area reclaim, slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: area reclaim, large stones.
33C, 33D, 34C3, 34D3-- Armstrong	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
37D--------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
37E--------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope, thin layer.
39C2-------------------- Clarinda	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
42C, 42C2, 42D--------- Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
44D-------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
52--------------------- Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
55B-------------------- Colo	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
61--------------------- Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
99. Pits				

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1B, 1C: Marshall	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
5C2: Clinton	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
7B, 7C: Sharpsburg	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
8C: Higginsville	Moderate: slope, seepage.	Moderate: wetness.	Frost action, slope.	Wetness, slope, erodes easily.	Erodes easily, wetness.	Erodes easily.
13: Haig	Slight	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
14B, 14B2, 14C, 14C2: Grundy	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Wetness, erodes easily.
16B, 16C: Ladoga	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
22: Wiota	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
23: Bremer	Slight	Severe: wetness, hard to pack.	Frost action	Wetness	Wetness	Wetness.
24: Nevin	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
26D: Vanmeter	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
29F: Vanmeter	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Gasconade	Severe: depth to rock, slope.	Severe: large stones.	Deep to water	Large stones, droughty.	Slope, large stones, depth to rock.	Large stones, slope, droughty.
33C: Armstrong	Moderate: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.
33D: Armstrong	Severe: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, percs slowly, wetness.	Percs slowly, slope, wetness.
34C3: Armstrong	Moderate: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
34D3: Armstrong	Severe: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, percs slowly, wetness.	Percs slowly, slope, wetness.
37D, 37E: Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
39C2: Clarinda	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Wetness, erodes easily.
42C, 42C2: Lamoni	Moderate: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.
42D: Lamoni	Severe: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.
44D: Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
52: Kennebec	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
55B: Colo	Moderate: seepage, slope.	Severe: wetness.	Frost action, slope.	Wetness, slope, flooding.	Wetness	Wetness.
61: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
99. Pits						

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1B, 1C----------- Marshall	0-9	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-40	5-15
	9-72	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
5C2-------------- Clinton	0-6	Silt loam--------	ML	A-4	0	100	100	100	95-100	30-40	5-10
	6-43	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	43-74	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
7B, 7C----------- Sharpsburg	0-16	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	16-53	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	53-75	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
8C--------------- Higginsville	0-9	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	95-100	25-35	8-15
	9-41	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	20-25
	41-66	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-22
13--------------- Haig	0-10	Silt loam--------	CL	A-6	0	100	100	100	95-100	30-40	10-20
	10-15	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	20-30
	15-45	Silty clay--------	CH	A-7	0	100	100	100	95-100	50-65	30-40
	45-74	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	20-30
14B-------------- Grundy	0-9	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-20
	9-16	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	25-35
	16-36	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	36-74	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
14B2------------- Grundy	0-7	Silty clay loam	CH, CL	A-7	0	100	100	95-100	90-100	40-55	20-35
	7-35	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	25-35
	35-46	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	46-60	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
14C-------------- Grundy	0-9	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-20
	9-16	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	25-35
	16-36	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	36-74	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
14C2------------- Grundy	0-7	Silty clay loam	CH, CL	A-7	0	100	100	95-100	90-100	40-55	20-35
	7-35	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	25-35
	35-46	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	46-60	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
16B, 16C--------- Ladoga	0-7	Silt loam--------	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	7-40	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	40-65	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
22--------------- Wiota	0-13	Silt loam--------	CL	A-6	0	100	100	100	90-95	30-40	10-20
	13-60	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	15-25
23--------------- Bremer	0-17	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-60	25-40
	17-42	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	100	95-100	50-65	20-35
	42-66	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-60	25-40

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
24 Nevin	0-18	Silt loam	CL	A-6, A-7	0	100	100	100	90-95	35-45	10-20
	18-65	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
26D Vanmeter	0-6	Silt loam	CL, CL-ML	A-4, A-6	0-5	90-100	90-100	90-100	70-100	25-40	5-15
	6-34	Silty clay loam, silty clay, clay.	CH, CL	A-7	0-5	90-100	90-100	90-100	85-100	40-65	20-35
	34-50	Weathered bedrock	CH	A-7	0-5	90-100	90-100	90-100	85-100	65-80	50-60
29F: Vanmeter	0-7	Silty clay loam	ML, MH	A-7	0-5	95-100	90-100	90-100	85-100	40-55	11-20
	7-36	Silty clay loam, silty clay, clay.	CH, CL	A-7	0-5	90-100	90-100	90-100	85-100	40-65	20-35
	36-57	Weathered bedrock	CH	A-7	0-5	90-100	90-100	90-100	85-100	65-80	50-60
Gasconade	0-4	Flaggy silty clay loam.	CL	A-6	20-70	75-90	70-65	60-75	55-65	30-40	15-25
	4-18	Flaggy silty clay, flaggy clay, very flaggy silty clay.	GC	A-2-7	20-70	45-55	40-50	30-40	20-35	55-65	35-45
	18	Weathered bedrock	---	---	---	---	---	---	---	---	---
33C Armstrong	0-8	Loam	CL, CL-ML	A-6, A-4	0-5	90-100	80-95	75-90	55-80	20-30	5-15
	8-41	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
	41-72	Clay loam	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
33D Armstrong	0-6	Clay loam	CL	A-6, A-4	0-5	90-100	80-95	75-90	55-80	35-45	15-25
	6-72	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
34C3, 34D3 Armstrong	0-5	Clay loam	CL	A-6, A-7	0-5	90-100	80-95	75-90	55-80	35-45	15-25
	5-72	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
37D, 37E Gara	0-10	Loam	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	10-36	Clay loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	36-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
39C2 Clarinda	0-9	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
	9-38	Silty clay, clay	CH	A-7	0	100	95-100	85-100	80-100	55-70	30-40
	38-64	Clay, silty clay	CH	A-7	0	95-100	95-100	80-95	75-90	55-70	35-45
42C Lamoni	0-16	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	16-44	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	44-60	Clay loam	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
42C2 Lamoni	0-6	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	6-72	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
42D Lamoni	0-16	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	16-44	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	44-60	Clay loam	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
44D Shelby	0-11	Loam	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	11-32	Clay loam	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	32-60	Clay loam	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
52 Kennebec	0-40	Silt loam	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	40-63	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
55B Colo	0-10	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	10-72	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
61---------------- Nodaway	0-65	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
99. Pits											

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic Matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
1B, 1C-----------Marshall	0-9	25-27	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Low-----------	0.32	5	6	3-4
	9-72	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
5C2--------------Clinton	0-6	16-26	1.30-1.40	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.37	5	6	1-2
	6-43	36-42	1.35-1.45	0.2-0.6	0.16-0.20	5.1-6.0	Moderate-----	0.37			
	43-74	24-35	1.40-1.55	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.37			
7B, 7C-----------Sharpsburg	0-16	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-7.3	Moderate-----	0.32	5	7	3-4
	16-53	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	53-75	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
8C---------------Higginsville	0-9	22-30	1.30-1.50	0.6-2.0	0.21-0.24	5.6-7.3	Low-----------	0.37	4	6	3-4
	9-41	27-35	1.40-1.50	0.6-2.0	0.14-0.19	5.1-6.5	Moderate-----	0.37			
	41-66	27-33	1.50-1.60	0.6-2.0	0.14-0.19	5.1-6.5	Moderate-----	0.37			
13---------------Haig	0-10	22-27	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	5	6	3-4
	10-15	28-48	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.0	High----------	0.37			
	15-45	40-50	1.30-1.45	0.06-0.2	0.12-0.14	5.1-7.3	High----------	0.37			
	45-74	28-40	1.40-1.50	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.37			
14B--------------Grundy	0-9	12-27	1.35-1.50	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	3	6	3-4
	9-16	32-45	1.35-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High----------	0.37			
	16-36	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High----------	0.37			
	36-74	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High----------	0.37			
14B2-------------Grundy	0-7	28-32	1.35-1.45	0.2-0.6	0.18-0.20	5.6-7.3	High----------	0.37	2	6	2-3
	7-35	32-45	1.35-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High----------	0.37			
	35-46	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High----------	0.37			
	46-60	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High----------	0.37			
14C--------------Grundy	0-9	12-27	1.35-1.50	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	3	6	3-4
	9-16	32-45	1.35-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High----------	0.37			
	16-36	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High----------	0.37			
	36-74	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High----------	0.37			
14C2-------------Grundy	0-7	28-32	1.35-1.45	0.2-0.6	0.18-0.20	5.6-7.3	High----------	0.37	2	6	2-3
	7-35	32-45	1.35-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High----------	0.37			
	35-46	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High----------	0.37			
	46-60	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High----------	0.37			
16B, 16C---------Ladoga	0-7	18-27	1.30-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Low-----------	0.32	5	6	2-3
	7-40	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	40-65	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
22---------------Wiota	0-13	24-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	3-4
	13-60	30-36	1.30-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
23---------------Bremer	0-17	25-32	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	5-7
	17-42	35-42	1.30-1.40	0.2-0.6	0.15-0.17	5.6-6.5	High----------	0.28			
	42-66	32-38	1.40-1.45	0.2-0.6	0.18-0.20	5.6-7.3	High----------	0.28			
24---------------Nevin	0-18	26-29	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	4-6
	18-65	30-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
26D--------------Vanmeter	0-6	18-24	1.30-1.40	0.2-0.6	0.18-0.20	6.6-8.4	Low-----------	0.43	3	6	1-2
	6-34	40-60	1.50-1.60	<0.06	0.12-0.14	7.4-8.4	High----------	0.32			
	34-50	40-75	1.70-1.90	<0.06	0.08-0.10	7.4-8.4	High----------	----			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
29F:											
Vanmeter--------	0-7	27-34	1.30-1.40	0.2-0.6	0.14-0.16	6.6-8.4	Moderate-----	0.43	2	4	1-2
	7-36	40-60	1.50-1.60	<0.06	0.12-0.14	7.4-8.4	High---------	0.32			
	36-57	40-75	1.70-1.90	<0.06	0.08-0.10	7.4-8.4	High---------	----			
Gasconade--------	0-4	35-50	1.30-1.45	0.6-2.0	0.12-0.15	6.1-7.8	Moderate-----	0.32	2	7	2-4
	4-18	40-60	1.45-1.70	0.2-0.6	0.05-0.07	6.1-7.8	Moderate-----	0.20			
	18	---	---	---	---	---	-------------	----			
33C--------------- Armstrong	0-8	22-27	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	3	6	2-3
	8-41	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High---------	0.32			
	41-72	30-36	1.55-1.75	0.2-0.6	0.14-0.16	5.1-7.3	Moderate-----	0.32			
33D--------------- Armstrong	0-6	27-38	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate-----	0.32	3	6	2-3
	6-72	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-7.3	High---------	0.32			
34C3, 34D3-------- Armstrong	0-5	27-38	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate-----	0.32	2	6	1-2
	5-72	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-7.3	High---------	0.32			
37D, 37E---------- Gara	0-10	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate-----	0.28	5	6	2-3
	10-36	30-38	1.55-1.75	0.2-0.6	0.16-0.18	4.1-6.5	Moderate-----	0.28			
	36-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-7.8	Moderate-----	0.37			
39C2-------------- Clarinda	0-9	30-38	1.45-1.50	0.2-0.6	0.17-0.19	5.1-7.3	Moderate-----	0.37	3	7	2-3
	9-38	40-60	1.45-1.60	<0.06	0.14-0.16	5.1-7.8	High---------	0.37			
	38-64	40-60	1.55-1.75	<0.06	0.14-0.16	5.6-7.8	High---------	0.37			
42C--------------- Lamoni	0-16	27-38	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	2	7	3-4
	16-44	38-50	1.55-1.75	0.06-0.2	0.13-0.17	5.1-7.8	High---------	0.32			
	44-60	32-40	1.75-1.85	0.06-0.2	0.14-0.18	6.1-7.8	High---------	0.32			
42C2-------------- Lamoni	0-6	27-38	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	2	7	2-3
	6-72	38-50	1.55-1.75	0.06-0.2	0.13-0.17	5.1-7.8	High---------	0.32			
42D--------------- Lamoni	0-16	27-38	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	2	7	3-4
	16-44	38-50	1.55-1.75	0.06-0.2	0.13-0.17	5.1-7.3	High---------	0.32			
	44-60	32-40	1.75-1.85	0.06-0.2	0.14-0.18	6.1-7.8	High---------	0.32			
44D--------------- Shelby	0-11	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	3-4
	11-32	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	32-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
52---------------- Kennebec	0-40	22-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	5	6	4-6
	40-63	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			
55B--------------- Colo	0-10	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	10-72	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
61---------------- Nodaway	0-65	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37	5	6	2-3
99. Pits											

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
1B, 1C------------ Marshall	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
5C2--------------- Clinton	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
7B, 7C------------ Sharpsburg	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
8C---------------- Higginsville	C	None---------	---	---	1.5-3.0	Perched	Nov-May	>60	---	High-----	Moderate	Moderate.
13---------------- Haig	C/D	None---------	---	---	1.0-2.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
14B, 14B2, 14C, 14C2-------------- Grundy	C	None---------	---	---	1.0-3.0	Perched	Nov-May	>60	---	High-----	High-----	Moderate.
16B, 16C---------- Ladoga	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
22---------------- Wiota	B	Rare---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
23---------------- Bremer	C	Rare---------	---	---	1.0-2.0	Apparent	Nov-May	>60	---	High-----	Moderate	Moderate.
24---------------- Nevin	B	Rare---------	---	---	2.0-4.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
26D--------------- Vanmeter	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High-----	Low.
29F:												
Vanmeter----------	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High-----	Low.
Gasconade---------	D	None---------	---	---	>6.0	---	---	9-20	Hard	Moderate	High-----	Low.
33C, 33D, 34C3, 34D3-------------- Armstrong	C	None---------	---	---	1.0-3.0	Perched	Nov-May	>60	---	High-----	High-----	Moderate.
37D, 37E---------- Gara	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
39C2-------------- Clarinda	D	None---------	---	---	1.0-3.0	Perched	Nov-May	>60	---	High-----	High-----	Moderate.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
42C, 42C2, 42D---- Lamoni	C	None---------	---	---	1.0-3.0	Perched	Nov-May	>60	---	Moderate	High-----	Moderate.
44D--------------- Shelby	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
52---------------- Kennebec	B	Occasional	Very brief to brief.	Nov-Jun	3.0-5.0	Apparent	Nov-May	>60	---	High-----	Moderate	Low.
55B--------------- Colo	B	Occasional	Very brief to brief.	Nov-Jun	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
61---------------- Nodaway	B	Occasional	Very brief to brief.	Nov-Jun	3.0-5.0	Apparent	Apr-May	>60	---	High-----	Moderate	Low.
99. Pits												

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
*Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Clinton	Fine, montmorillonitic, mesic Typic Hapludalfs
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Gasconade	Clayey-skeletal, mixed, mesic Lithic Hapludolls
Grundy	Fine, montmorillonitic, mesic Aquic Argiudolls
Haig	Fine, montmorillonitic, mesic Typic Argiaquolls
Higginsville	Fine-silty, mixed, mesic Aquic Argiudolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Ladoga	Fine, montmorillonitic, mesic Mollic Hapludalfs
Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
Nevin	Fine-silty, mixed, mesic Aquic Argiudolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Vanmeter	Fine, illitic, mesic Typic Eutrochrepts
Wiota	Fine-silty, mixed, mesic Typic Argiudolls

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range for the series.

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U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISSOURI AGRICULTURAL EXPERIMENT STATION

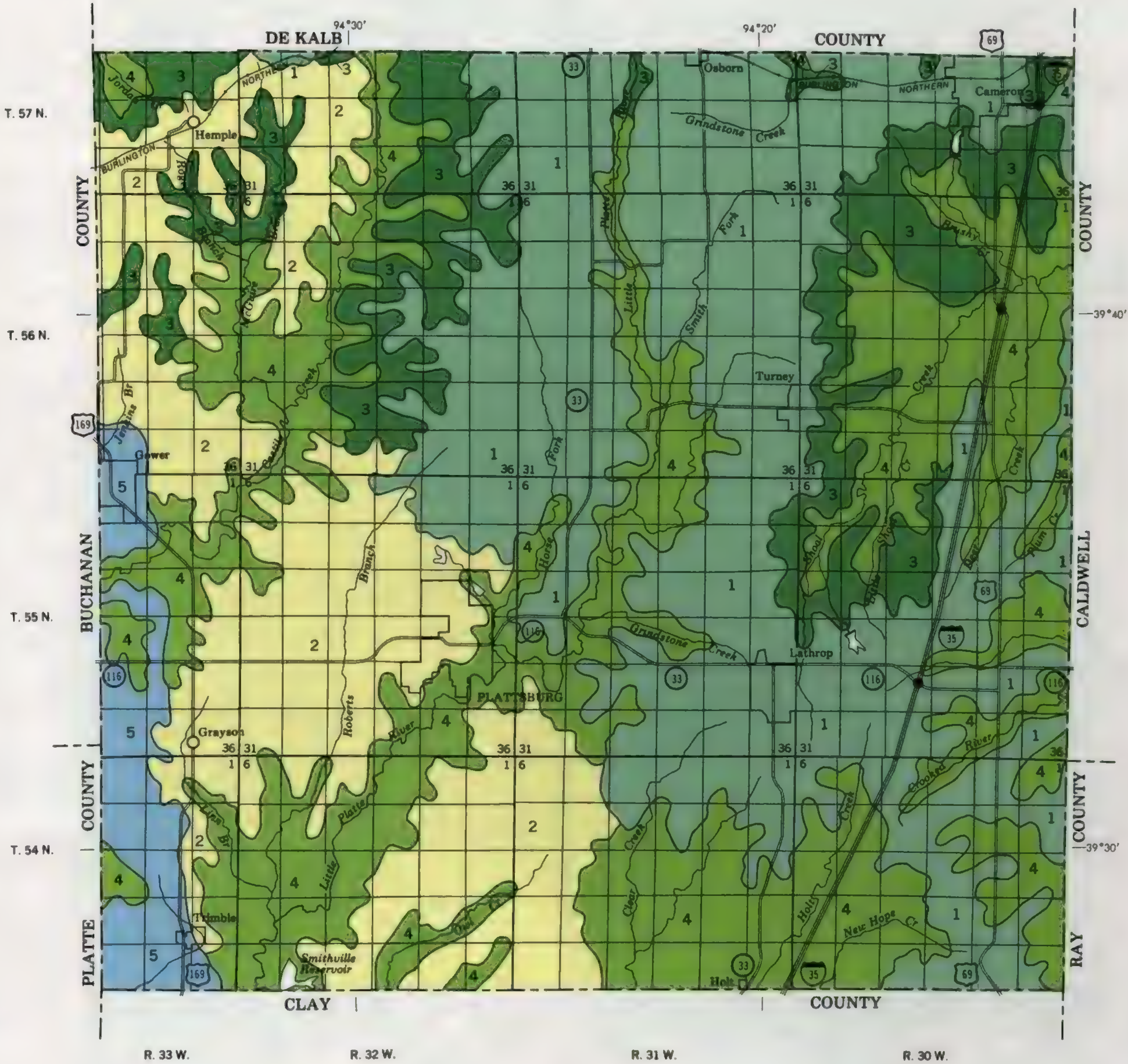
GENERAL SOIL MAP

CLINTON COUNTY, MISSOURI

Scale 1: 190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers



SOIL LEGEND

1	Grundy association: Somewhat poorly drained soils that formed in loess
2	Sharpsburg-Higginsville-Lamoni association: Somewhat poorly drained and moderately well drained soils that formed in loess and glacial till
3	Lamoni association: Somewhat poorly drained soils that formed in glacial till
4	Armstrong-Gara-Ladoga association: Moderately well drained and somewhat poorly drained soils that formed in loess and glacial till
5	Marshall-Higginsville association: Well drained and somewhat poorly drained soils that formed in loess

Compiled 1981

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

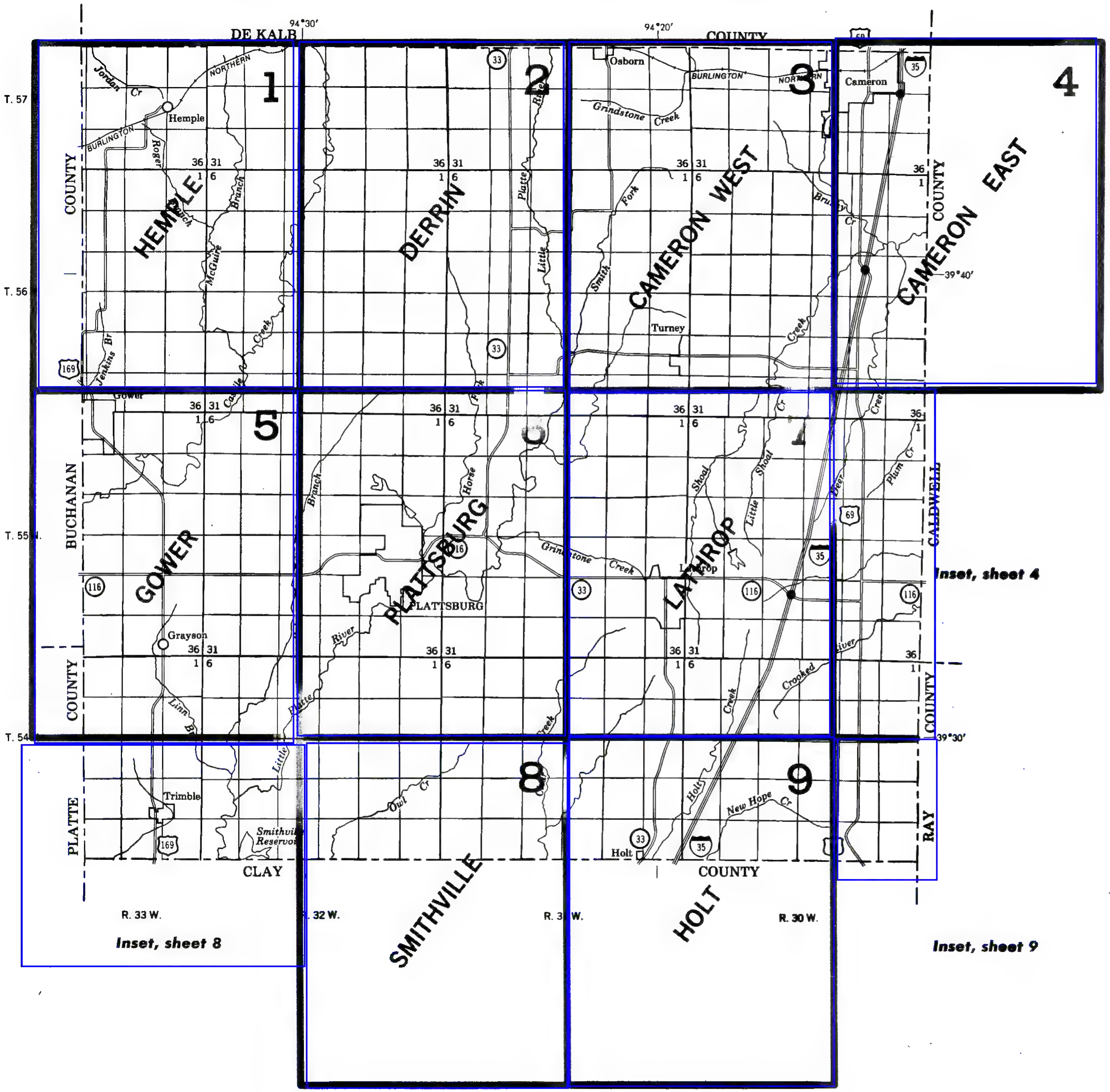
6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS
CLINTON COUNTY, MISSOURI

Scale 1:190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
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30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for the nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is moderately eroded and 3 that it is severely eroded.

SYMBOL	NAME
1B	Marshall silt loam, 2 to 5 percent slopes
1C	Marshall silt loam, 5 to 9 percent slopes
5C2	Clinton silt loam, 5 to 9 percent slopes, eroded
7B	Sharpsburg silty clay loam, 2 to 5 percent slopes
7C	Sharpsburg silty clay loam, 5 to 9 percent slopes
8C	Higginsville silt loam, 5 to 9 percent slopes
13	Haig silt loam
14B	Grundy silt loam, 2 to 5 percent slopes
14B2	Grundy silty clay loam, 2 to 5 percent slopes, eroded
14C	Grundy silt loam, 5 to 9 percent slopes
14C2	Grundy silty clay loam, 5 to 9 percent slopes, eroded
16B	Ladoga silt loam, 2 to 5 percent slopes
16C	Ladoga silt loam, 5 to 9 percent slopes
22	Wiota silt loam
23	Bremer silty clay loam
24	Nevin silt loam
26D	Vanmeter silt loam, 9 to 14 percent slopes
29F	Vanmeter-Gasconade complex, 14 to 50 percent slopes
33C	Armstrong loam, 5 to 9 percent slopes
33D	Armstrong clay loam, 9 to 14 percent slopes
34C3	Armstrong clay loam, 5 to 9 percent slopes, severely eroded
34D3	Armstrong clay loam, 9 to 14 percent slopes, severely eroded
37D	Gara loam, 9 to 14 percent slopes
37E	Gara loam, 14 to 20 percent slopes
39C2	Clarinda silty clay loam, 5 to 9 percent slopes, eroded
42C	Lamoni silty clay loam, 5 to 9 percent slopes
42C2	Lamoni silty clay loam, 5 to 9 percent slopes, eroded
42D	Lamoni silty clay loam, 9 to 14 percent slopes
44D	Shelby loam, 9 to 14 percent slopes
52	Kennebec silt loam
55B	Colo silty clay loam, 2 to 5 percent slopes
61	Nodaway silt loam
99	Pits, quarry

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

County

Reservation (state park)

Neatline

AD HOC BOUNDARY (label)

Cemetery

STATE COORDINATE TICK

LAND DIVISION CORNERS
(sections and land grants)

ROAD EMBLEMS & DESIGNATIONS

Interstate 35

Federal 69

State 33

County HH

DAMS

Large (to scale)

Medium or small water w

WATER FEATURES

DRAINAGE

Perennial, single line

Intermittent

Drainage end

LAKES, PONDS AND RESERVOIRS

Perennial water w

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS 13 44D

MISCELLANEOUS

Rock outcrop
(includes sandstone and shale)

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 1
CLINTON COUNTY, MISSOURI
(HEMPLE QUADRANGLE)

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1974 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
Scale 1:24000

N

CLINTON COUNTY, MISSOURI NO. 1

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1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
Scale 1:24000

N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 3
CLINTON COUNTY, MISSOURI
(CAMERON WEST QUADRANGLE)

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1974 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
Scale 1:24000

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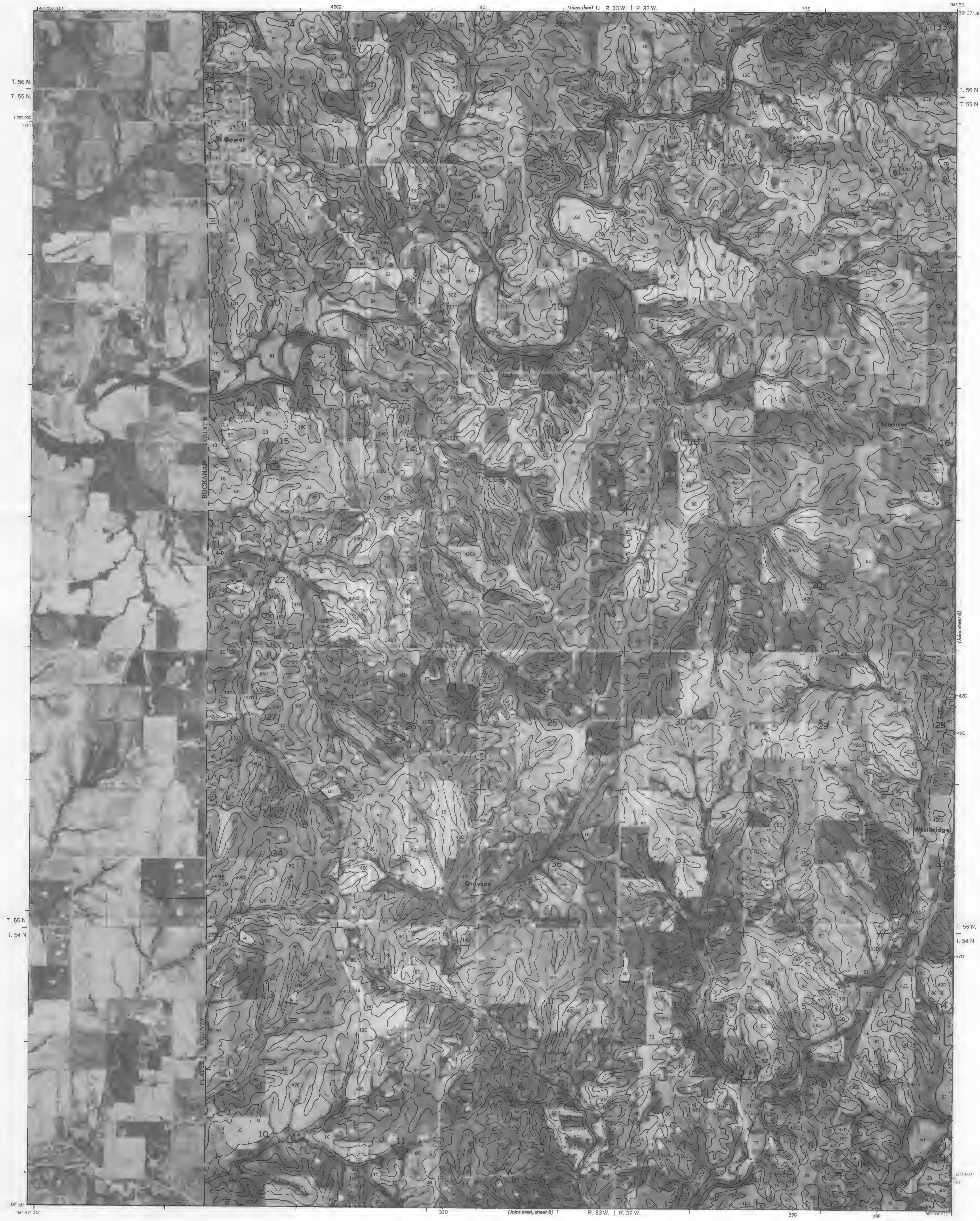
1 0.5 0 1 2 KILOMETERS

Scale 1:24000

N



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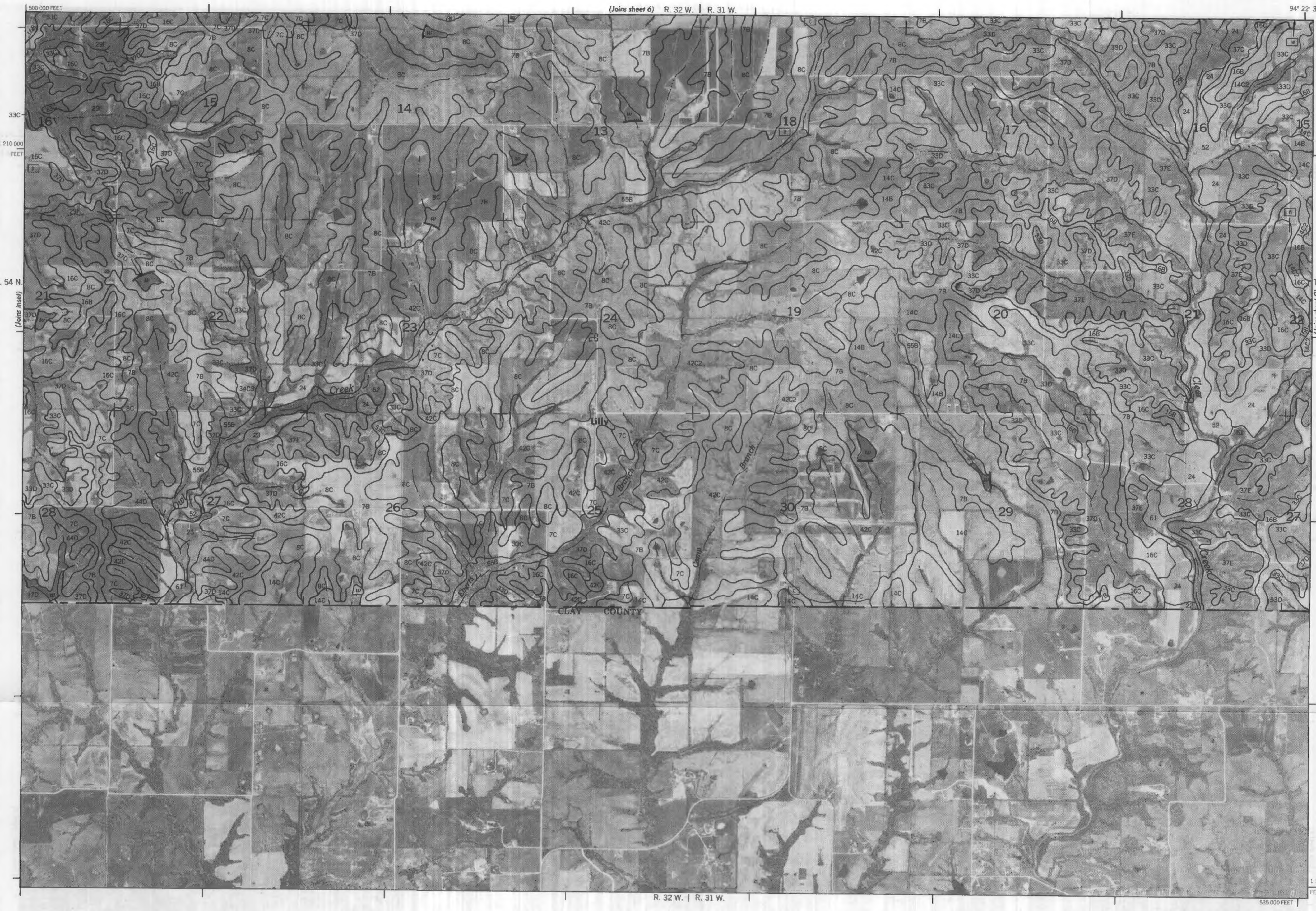

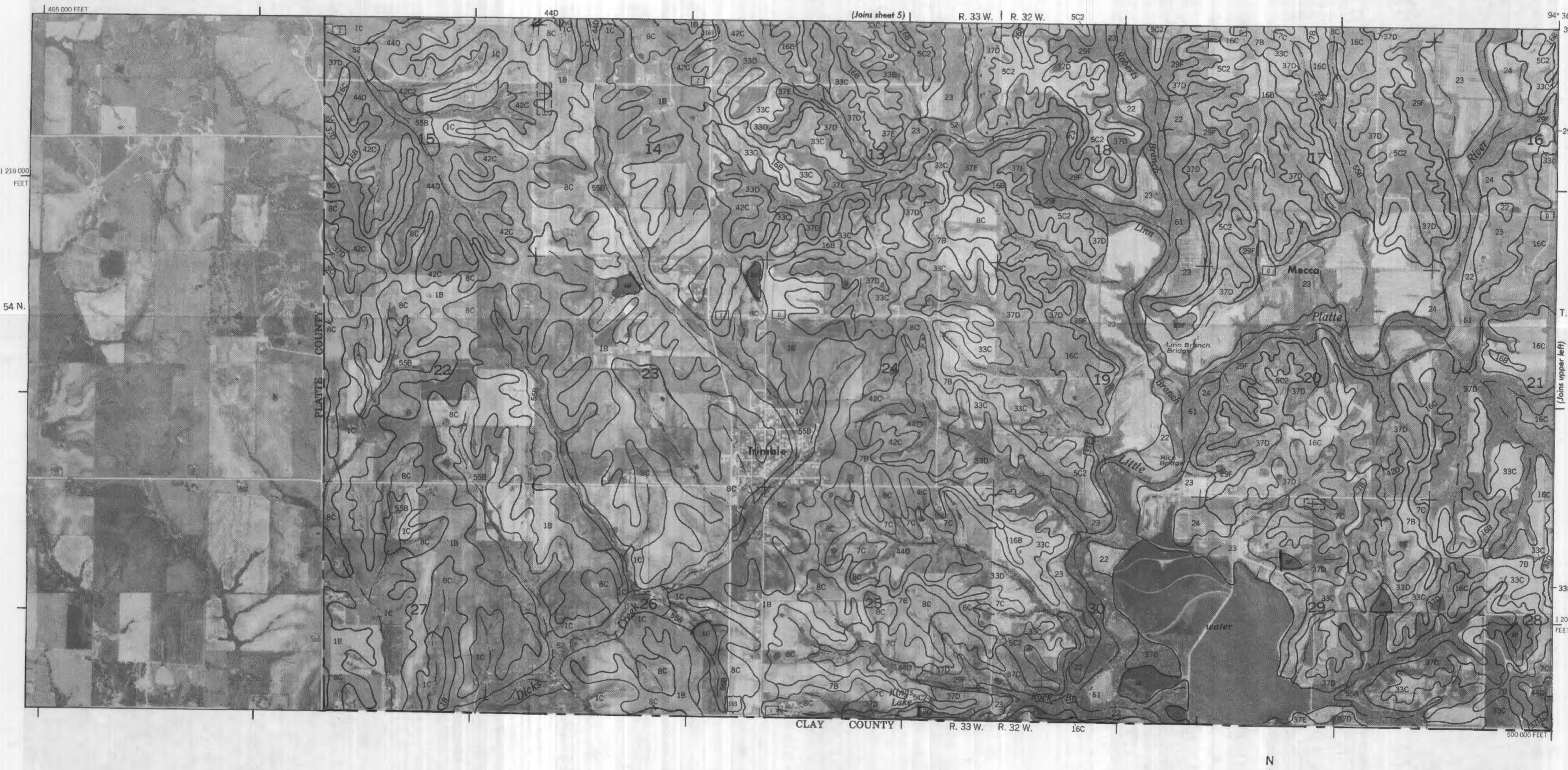

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Scale 1:24000

1 3/4 1/2 1/4 0 1 2 MILES

1 0.5 0 1 2 KILOMETERS

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